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ABSTRACT

These three documents outline teaching activities intended to involve children with their environment. Suggested preliminary studies to motivate and familiarize elementary school students with some characteristics of organisms and their physical environment are followed by descriptions of class activities that may be undertaken in the field. Suggestions for classroom analysis of the data at the conclusion of the study are included. Methods of sampling habitats are described; the transect technique is recommended. Simple techniques for measuring physical factors (such as precipitation, light intensity, humidity, wind velocity, and soil composition and characteristics) as well as collection and observation techniques for organisms (plants, soil micro-organisms, invertebrates and vertebrates) are described. Details of construction of any apparatus required are included. This work was prepared under an ESEA Title III contract. (AL)

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# HABITAT STUDY
# TRANSECT STUDY

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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# Introduction to the Teacher

Learning about our environment has recently gained popularity because of the essential need for knowledge in this area. Individual students and citizens will soon need to understand relationships in nature. They will need to think reasonably and knowledgeably about environmental decisions.

The Environmental Science Center develops materials that involve children directly in experiences that lead to learning about their environment. Therefore, our material is ecology oriented. Ecology is the study of dependence and interdependenc in the whole environment. By studying portions of the school area and a field site in depth, the children will be made aware of some of the interdependence factors.

It is not essential that a teacher know "all about" a subject to be able to enthusiastically encourage children to become involved in an investigation. In fact, it can be an asset to have little background in an area to be studied because then the teacher can honestly display interest, surprise, and enthusiasm for the new experience.

This study has been organized to include pre-activities in the school or the surrounding areas, field trip activities, and post-activities usually conducted at the school. An outline of these activities follows:

I. Pre-Activities

A. Familiarize the children with

1. tools
2. methods
3. the study

B. Give the children background experiences for the field work.

C. Make investigations similar to the field site studies.

1. collect data
2. combine data
3. make generalizations

II. Field Study

A. Collect data

B. Combine data (if time permits)

It is well to note that children will seldom be defeated by rainy or chilly weathe conditions. If the teacher dresses for the occasion and remains cheerful, with a "we can do it" attitude, it will be possible to transfer this attitude to most of the children.

III. Post-Activities

A. Combining data

B. Ordering data

1. charts
2. graphs
3. displays

C. Comparing data

D. Looking for relationships

E. Making statements concerning relationship (generalizing)

The responsibility for seeing relationships and making generalizations rest completely with the children. However, we have included guidelines in the form of questions that may be posed to guide the children's thinking. Remember, we are not looking for neat, pat answers (there may not be any), but for an awareness of interrelationships.

Each activity presents background experience that is essential to activities that follow. Plan to give ample time for all portions of this lesson so the individuals involved will have the most meaningful learning experience.

# HABITAT STUDY

I. Pre-Activity — Collection of insects from home area

Objective: 1. Familiarize students with killing invertebrates for a comparative study involving kinds and numbers.

2. Encourage awareness that populations of animals differ in different environments.

Materials: masking tape
3 x 5 cards
white glue
commercial grade ethyl or isopropyl alcohol solvent
(from a paint or hardware store)
pill bottles or babyfood jars
thumb tacks

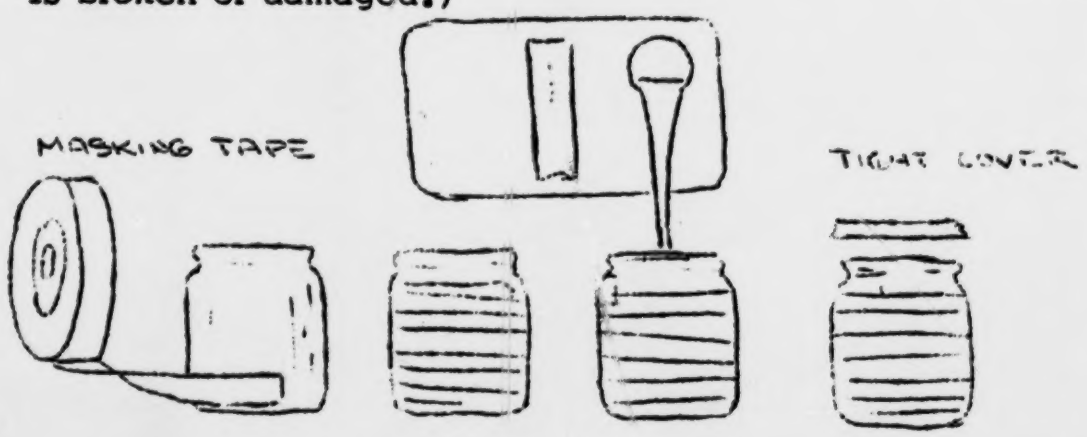
A. Build an insect killing jar (one for each student)

1. Have each child bring a pill bottle or small babyfood jar to school.

2. Purchase:

a. a large roll of masking tape
b. alcohol

3. Have each child construct his insect killing jar in the following manner: (Put tape around jar to prevent shattering in case the jar is broken or damaged.)



Or, use small plastic refrigerator dishes

4. Pour about 1/2 inch of alcohol in each child's jar and seal it tightly.

B. Collecting

1. Have the children catch five different "bugs." They may catch them in any manner they choose. They should not collect an abundance of "bugs' but should let extras go again after they have the five they need. Collecting only what is needed is good conservation practice.

2. Kill the "bugs" by dumping them into the killing jar and quickly replacing the cover. Leave the jars sealed for at least thirty minutes. (If someone has caught a bee or hornet in a net or other jar, chill it in the refrigerator for a half hour before transferring it to the killing jar. The cold slows invertebrate animals which makes stinging and biting insects safer to handle.)

3. Each student should keep a record of where each of the insects were found and a rough description of what the place was like. For example: "The black shiny 'bug' was in the dirt in our garden," or, "The ant was crawling on the sidewalk," or, "The worm was in a muddy place in the yard after the rain," or, "The 'bug' was sitting on a tree leaf."

C. Preparing for display

1. Remove the "bugs" from the killing jar and lay them on paper toweling to dry for five or ten minutes.

   The wings of butterflies and moths will be damaged by this procedure, but it is not the purpose of this lesson to make a pretty display.

2. Mounting the bugs

   a. Give each child several 3 x 5 cards divided into four or six areas by lines and some white glue (turns clear when dry).

   b. Have each child mount their "bugs" in the following way: Put a drop of glue on a square of the card and place a "bug" on top of the drop, letting the "bug" settle into the glue. Allow the cards to set for 1/2 hour or until the next day to be sure the glue has hardened.

D. Studying the "bugs"

1. Allow the children to compare collections.

2. Categorize the collections.

   a. Divide a bulletin board or wall chart into three or four areas (leave space for a few more).

   b. Have the students decide what major kinds of <u>places</u> the insects which they collected came from. Have them decide this on the evidence provided by the records they kept on where they caught their insects.

      Label the areas of the bulletin board accordingly: e.g. sidewalks, lawn, porches and garages, garden dirt, on trees and bushes, etc.

c. The students should then separate their mounted "bugs" by cutting the mounting cards along the division lines. When the "bugs" are separated, each student will tack his mounted insect to the most appropriate area on the bulletin board according to the information from his record. They should tack them on the bulletin board with thumbtacks so they can easily be moved around.

3. Discuss the display of "bugs." Have the students look for any patterns they might see in the display.

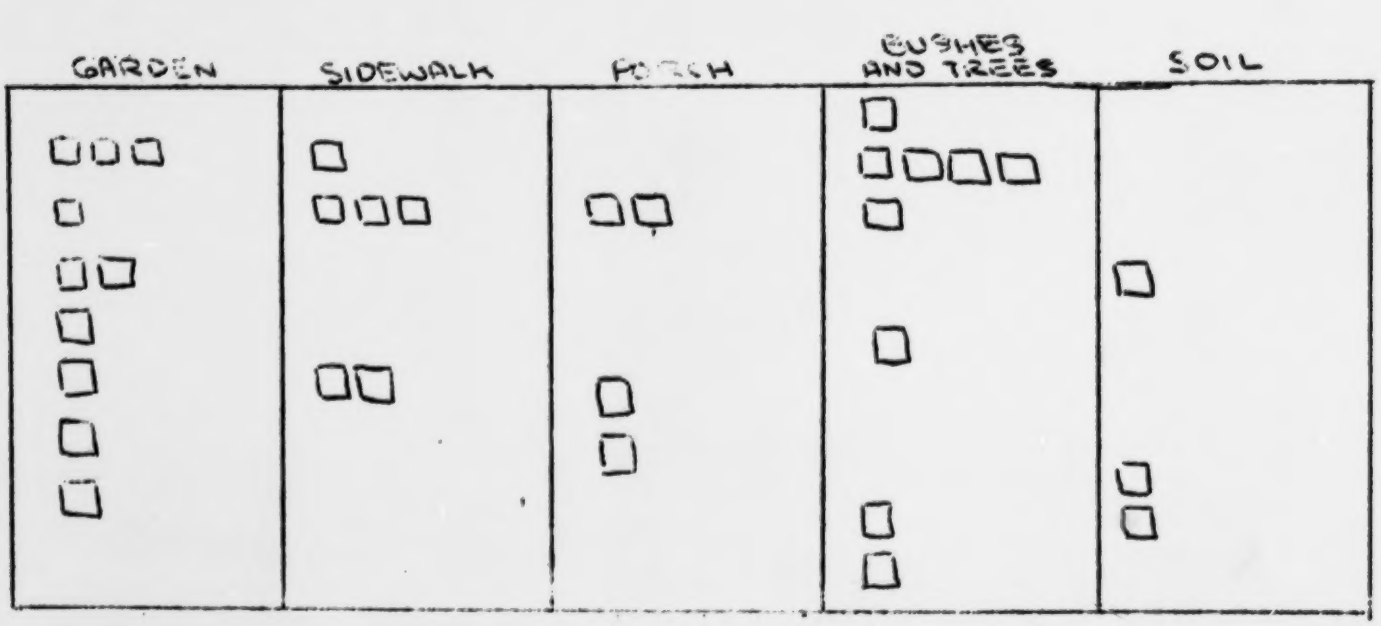
   a. Are there more than one of the same kind of bug in the display? Where are they found? Arrange the same kind of "bugs" in a row in each location area.

   b. Where were the most "bugs" (of all kinds) found? Count them.

   c. Were some kinds of bugs found in all locations — in more than one location? Arrange the same kind of "bugs" so they are in like places in each of the areas of the bulletin board. Are there any other patterns which show themselves?

   d. Can the students predict where certain kinds of "bugs" would most likely be found if they hunted for them again? Be sure that students use only the information from the display as evidence for their predictions.

4. A final display of "bugs" may look something like this:




5. There is no need to identify "bugs" by name for this study. If students want, they could identify them from handbooks as extra projects on their own. Students may like to invent their own names for the "bugs."

   Students may be interested in finding other ways of ordering the "bugs" i.e., by structure, number of wings, color, size, etc.

# HABITAT STUDY

II. Pre-Activity — Soil samples

Objective: 1. Give experience in a technique of analyzing soil types.

2. Demonstrate that soil is made up of several components.

3. Create an awareness that soils differ in different locations.

Materials: plastic bags
digging tools (spoons, etc.)
several tall olive jars, test tubes, or similar transparent containers
waterproof marking pen
graph paper

A. Determine several locations around the school which have a different appearance, use, or plant cover. Have the class help decide which locations should be chosen. Get permission to dig some small holes in these locations

B. Assign teams of two or three. Divide the teams up among the several locations selected — two or more teams to each. Give each team a digging tool and two plastic bags marked "A" and "B" with a marking pen. Label the bags with some designation for each location. Each team will have the following tasks:

1. Scrape away the surface plants and debris in a small area and collect a handful of soil from the surface of the ground and put it in plastic bag "A".

2. Then dig down in the same place to a depth half way up to their elbow. Take a sample handful of this sub-soil from the bottom of the hole and put it in bag "B".

Replace the extra soil in the hole and cover the bare spot with the plants and debris that were scraped from the surface.

C. Display the samples of soil. Group them by location. See if students can find any differences or similarities among them. Can students determine what factors in the soil make certain differences and similarities?

D. Analysis of soil

1. Have each team half fill a tall jar or test tube with soil sample "A".

2. Fill the rest with water and shake thoroughly. Set container in a vertical position where it will not be disturbed for 24 hours.

3. After 24 hours, notice the settling of soil particles. Where are the largest particles? Where are the smallest particles? The largest particles are called sand. The smallest are called clay. Particles a little coarser than clay are called silt. You may see two layers of sand, coarse and fine. Floating items are humus or dead plant material. Can the students identify their layers? How many layers do they have?

4. Compare soil samples from the same location. Are they more alike than those from different locations?

5. Draw a representation of the layers of the soil sample on graph paper. If all the jars or test tubes were the same size, students can measure the depth of the layers with a ruler and translate this directly on to the graph paper. If the containers are different sizes, then a standard graph size should be prescribed and the students can translate proportionate depths onto their graphs by estimation. Or, students can determine the percentage of each of the layers by dividing the depth of the total sample into the depth of the individual textures.

$$100 \times \frac{\text{depth of one layer}}{\text{total depth of soil}} = \underline{\qquad\qquad} \%$$

6. Do the same analysis of soil sample "B".

7. Display all the graphs by location.

8. See if the students can now find more accurate ways of comparing differences and similarities of the various samples.

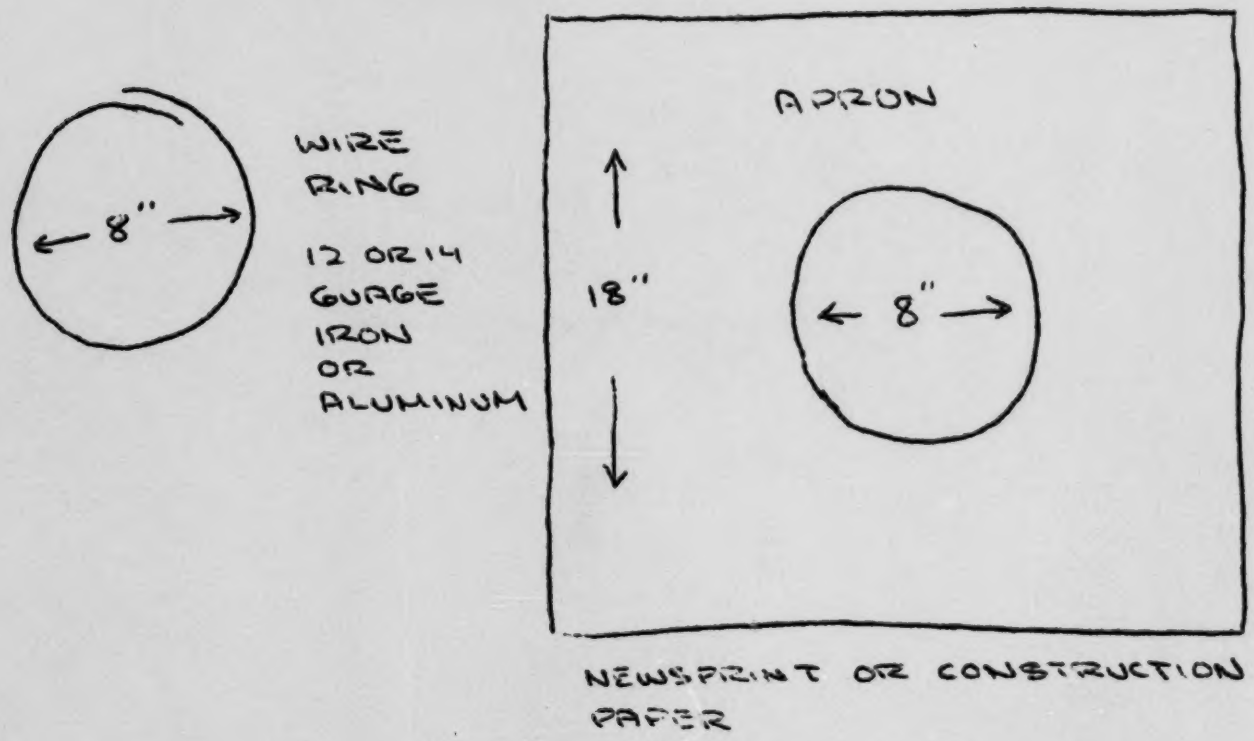
## HABITAT STUDY

### III. Collecting On-Site

Objective: 1. To collect material for classroom study.

2. To expose students to the conditions of a relatively undisturbed natural area.

Materials: killing jar (prepared in pre-activities)
wire ring or coathanger in its original shape
paper apron for around the wire ring
dozen plastic sandwich bags
two medium grocery bags
spoon or something small to dig with




A. Decide on <u>two</u> distinctly different locations to study. These locations will depend on the site visited. You might have a selection of many different locations or just a few. For example, you might have a woodlot and a grassy area; a swampy spot, and a sandy area; etc.

B. Assign half the class one location to study first, and the other half the other location to study first. When they have completed the study of one area, they may go to the other and repeat the investigation.

C. Sampling an area. Students will do the following in both locations:

1. From a standing position, toss the wire ring lightly on the ground a few feet away. Do not inspect the area first!
2. Place the apron around the ring.
3. Search carefully through the leaf litter and material within the loop.

   Three sets of material will be collected from the ring area.

   a. Living things

      1) Animals: Catch all "bugs" and put them into the killing jar. Lay any other material removed from the area onto the apron.

      2) Plants: Scoop up all living plants or tiny plant shoots with some soil and place them gently into baggies.

   b. Dead materials: Sort and place all leaf litter into the baggies — twigs in one, leaves in one, dead insects and dead snails in one, and animal droppings in another. Crushed, broken leaf litter which cannot be recognized as individual leaves can be placed in a separate bag. Be sure to include the materials which were placed on the apron when searching for "bugs."

   c. Soil materials: Pick out pebbles and put into a bag. Take a handful of soil and place in a bag.

4. Put all the plastic bags of material into a paper sack and label the sack with the field location, e.g. woods, or swamp. Have the students put their names on the sacks to avoid mix-ups.

Everything from the ring is collected into bags. There should be bare dirt exposed if a complete job has been done.

# HABITAT STUDY

## IV. Post-Activities

Objective: To (1) organize; (2) correlate; (3) compare; and, (4) draw conclusions from gathered materials.

Materials: white glue
graph paper (various sizes)
thumbtacks
plastic cups
plastic bags
potting soil

Complete the following procedures for each area studied before looking at a different area. For example, if you examined an oak woodlot and a grassy field on the field trip, complete the procedure for one before starting another, and then compare the two.

A. First look at all the material and have the class determine which is most and which is least abundant in nature: the living, the dead, or the mineral materials.

B. Mineral material

1. Separating rocks (there may be only one type of pebble or there may be none at all.)

   a. Each child should dump the bag of stones on their desk.

   b. Study them carefully to see if there are any different types of stones. Separate the types if you find any.

   c. Using 1 or 1/2 inch graph paper, graph the number of each type of stone found in your plot. Stones can be glued directly to the graph paper. Allow to dry over night before displaying.

   d. Allow the children time to compare their individual graphs as to types and number of stones.

2. Making a class graph of rocks

   a. Cut the individual columns of your graph apart.

   b. Tape each child's column of a certain rock end-on-end forming one long column for the class. You could do this on tagboard or on the bulletin board. Tape all other rock types in the same way, placing each strip side by side. You should have a graph of the relative abundance of rock types when you have finished.

3. Making a class graph of the soil samples (there may not be more than one type of soil.)

   a. Discuss the soil samples with the children. Ask if anyone had a very unusual soil sample. Allow the class to observe each other's samples for color, texture, content (sand, gravel, etc.). This activity gives them some perspective for making judgments in placing

their soil on the class graph. Each child should put his name and the site location on this bag to avoid confusion.

b. Prepare graph paper with squares five inches on a side. Attach this to poster board or the bulletin board.

c. Have the children one at a time tape their plastic bag full of soil on the graph paper. They should examine all soils that are already on the graph. If theirs is like one already up they should add theirs to that column of the graph. If it is different they should start a new column. (The graphing of the soils might take place while some other work is going on.)

d. Further work with soil analysis may repeat the procedures in Section II on page 4 .

C. Dead material (living at one time)

1. Separating the dead material (if it has not been done in the field)

a. Have the children dump their bags of "leaf litter" on their desks and begin to separate it. Use a hand lens if necessary.

1) All dead insects, empty snail shells, "shed insect skin", etc. might go in one pile.

2) Leaves in a second pile.

3) Sticks and twigs in another pile.

4) Animal droppings in a fourth pile (they should be dry and hard and easily handled).

b. Place each pile in a separate bag.

2. Studying the remains of animals (bag "a")

a. Divide this up into piles of "look alikes."

b. Glue them onto light cardboard in the same way you mounted the "bug" collection. (see page 4 )

c. Allow the children to compare and discuss their individual collections.

d. Prepare a class graph of animal remains using the same procedure used for graphing the soil samples.

Alternative: If you have a good quantity of empty snail shells, prepare a class graph of them according to size. Which size shell did they find the most of?

3. Studying the dead leaves or grass (bag "b")

a. Separate the leaves into separate piles of each type.

b. Prepare a class graph of the leaf types.

4. Studying the twigs and sticks (bag "c")

   a. Separate the twigs into piles that you think "came from the same type of tree."

   b. Prepare a class graph of the twig types.

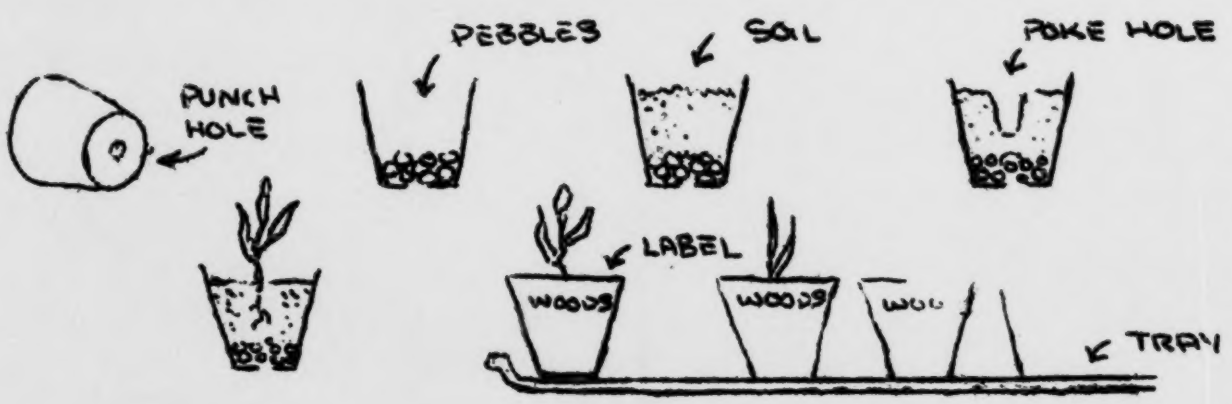
5. Studying animal droppings (bag "d")

   a. Separate the droppings into different types if you have more than one type.

   b. Prepare a class graph of the animal droppings. (Possible droppings you might find are rabbit — round, pea size, brown; and mice — tiny, oval, black). Glue them to the graph paper.

D. Living material — Plants

1. Plant all the tiny plant shoots in plastic coffee cups.




   Place them in a window.

2. Group "look alikes" together. Which group is largest?...Smallest?

3. Watch them grow.

   a. Which are tree sprouts?

   b. Which are weeds?

   c. Which are grasses?

4. Or, keep the plants in plastic bags and compare and order them in a display on the bulletin board.

E. Living material — "Bugs"

1. Dry the "bugs" after returning to the classroom. Use the same procedure used in the pre-activities. (see page 4 )

2. Have individuals mount them as they did in the pre-activities.

3. Allow time and discussion for comparison of collections.

4. Set up a classification system by location, similar to the way the pre-activity system was set up. With the pre-activity experience in their background, the children may be able to do this with little direction.

F. Questioning the graphs — Study the graphs as each one is completed and/or when they are all completed. Note what the dominant type of material or organism is in numbers or amount for that location, e.g. oak woodlot. What are the distinguishing characteristics of this location?

G. Repeat the above procedures for the other area studied, e.g. grassy field.

H. How does one area compare with the other in respect to:

1. the common minerals?
2. types of dead material?
3. proportion of dead to living material?
4. types of "bugs" inhabiting the floor of the area?
5. which plants are present in the greatest numbers?
6. any other relationship the students can see.

# TRANSECT STUDY

## I. Pre-Activity — Coathanger Count

Objective 1. To familiarize students with a procedure for sampling and comparing plant populations prior to a more complex field investigation.

2. To demonstrate that plant populations differ under different environmental conditions.

Materials: coat hangers (one for each two students)

plastic sandwich bags — fold lock top kind

notepaper and pencils

### Procedure

Have the class select <u>three</u> different locations around the school yard. Do this before the class begins its survey. The three locations should be different in the general appearance of the plant cover, but great differences are not necessary. Different locations may be found among sodded lawn, natural lawn, boulevard, playground, sunny location, shady-all-day location, vacant lot (mowed), etc. Mark the locations with flags or other markers.

Assign partners. Assign about equal numbers of student teams to each of the <u>three</u> different locations. Give each location a name, i.e. location "A", location "B", location "C". Give each team a coat hanger.

Have each team prepare a data sheet similar to the following. (Attach the bags as greatly separated from each other as the page allows.) (Staple bags to the sheet with the tops open so the plants may be easily inserted.)

---

DATA SHEET Location _____

1. Put <u>one</u> of each different type of plant found within the coat hanger in a separate bag.
2. Count and write the number of that kind of plant after the bag containing the sample.

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

Each team will have the following responsibilities on location:

1. Close eyes and gently toss the coat hanger onto the location to be sampled.
2. Take <u>one</u> sample of each <u>different kind</u> of plant found inside the area defined by the coat hanger. Put each kind of sample in a separate plastic bag on the data sheet. Try to get all of the plant.
3. Count the number of each kind of plant growing within the coat hanger area. Write this number on the data sheet beside the bag containing the plant.

In a thick lawn, grass plants may be very numerous. It is a help in counting to have a length of string to mark off those plants which have already been counted. Move the string when 10, 20, 30, etc. plants are counted so that the count is not lost. (Some students may differentiate between different species of grass. This is not necessary for this study and the samples of different grasses can be lumped together if you choose.)

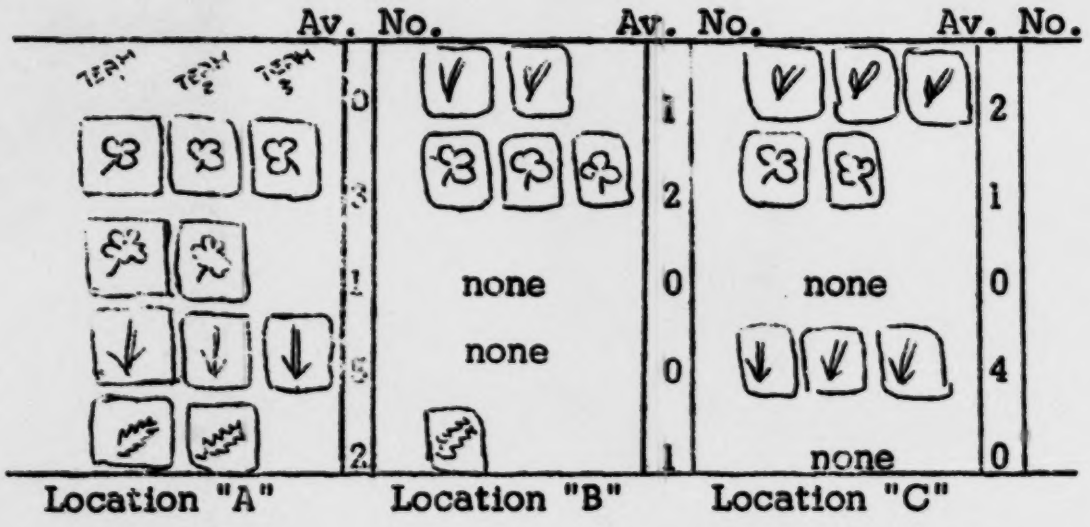
A collection and comparison of data is necessary after the survey. Teams which sample the same location should get together and find out how many different plants they discovered and if all teams discovered the same kind of plants. They should compare the samples with each other. This should be done while the sample plants are still fresh. If the samples are detached from the data sheet they should be marked with the location, the number of plants, and the names of the teammates.

It is not important to know the names of the plants. But, if students think they know the name of a plant, be sure it is an accepted one before labeling it for the whole class. They might make up their own names for the plants for easier communication.

The teams for each location should find the average number of each kind of plant per coat hanger area. That is, add the counts for each plant type from all teams in one location, and then divide by the number of teams (even if one or more teams did <u>not</u> find that particular plant).

To make comparison easier, a display for each location can be made by removing the bags from the data sheet and taking the sample bags to a bulletin board. Write the average number beside the sample bag. A class display of the entire sampling may look like this:

Average Number of Plants of Each Type for Location



Have the class recall the general characteristics of their three locations. Have them discuss any relationships between the general conditions and the data they collected.

Students will want to propose many assumptions as to why they got the data they did. Keep asking if it is possible to really know for sure that their assumption is true. Ask how they could test to find out if their assumption is true. (This kind of investigation may be followed up at this point, but the students will have a better understanding of tests that can be made following the visit to the field site.)

Ask the students just how much can be known from the data which they collected. They should look at the chart alone and forget about trying to explain how the chart got that way. Actually, the chart tells all that can be known.

-- One kind of plant may grow in all three locations.

-- One kind of plant may be more abundant in lawns than on playgrounds.

-- Two kinds of plants may occur only on playgrounds.

It is important for students to realize that knowledge and understanding is limited by the amount of measured data that is collected.

## TRANSECT STUDY

II. Pre-Activity — Temperature Differences

Objective: To familiarize students with handling a measuring device and collecting data from it.

To demonstrate that soil temperatures vary under different environmental conditions.

To demonstrate that surface temperature varies under different environmental conditions.

Materials: thermometers (preferably simple with the bulb exposed so that it can come in contact with the soil) (one per each two or three students)
garden trowels or old table knife or spoon to dig a slit in the ground for the thermometer
notepaper and pencils

### Procedure

Select a variety of locations before the class activity. If the class has done the coat hanger count (see page 14) be sure to include the three locations from that survey in your selections for temperature readings. If several locations are selected it is most convenient for the students if you mark each with a numbered piece of paper pinned to the ground by a pencil or stick.

Locations which show a difference of temperature could include sout-facing slope, north-facing slope, shaded soil, moist soil, dry soil, near a building, heavy plant cover, no plant cover, windy area, open area, sheltered area, etc. Pick some locations which have the same conditions.

Assign partners for teams of two or three. Assign at least three locations to each team. Teams could rotate to all locations if time permits.

Each team will have the following responsibilities on location:

1. Place the thermometer flat on the ground with bulb up and record the temperature when the fluid stops moving.
2. Make a slit in the soil by forcing in a trowel or table knife and prying forward. Pull the digging tool back. Slide the thermometer bulb into the slit to a depth of about 3 centimeters. Slip the tool out and close the soil against the thermometer.
3. Read the thermometer only after the fluid stops moving. Scrape away enough soil to take the reading. Record the surface and soil temperatures along with the location number.

4. Note also the water in the soil. Make a rough estimate of whether the soil is dry, moist, or wet. Record this next to the temperature.

5. Observe the characteristics of the location and write a few words to indicate if there is shade, a slope to the ground surface, and anything else which the students think might influence the temperature.

Collect and compare the data by recording the reports of each team on a large chart. Make the chart from paper or put it on the chalk board. It could look like this:

Locations

| | 1 | | | 2 | | | 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Temp | | | Temp | | | Temp | | |
| | Sub | Surf. | Soil | Sub | Surf. | Soil | Sub | Surf. | Soil |
| Team A | 70 | 71 | Moist | 65 | 67 | Moist | 64 | 65 | Moist |
| B | 71 | 73 | Moist | 62 | 63 | Moist | 65 | 68 | Wet |
| C | 69 | 71 | Moist | 67 | 69 | Moist | 63 | 65 | Moist |
| D | 70 | 72 | Moist | 66 | 68 | Moist | 64 | 67 | Moist |
| E | 70 | 72 | Moist | 65 | 67 | Wet | 64 | 66 | Wet |
| F | 71 | 73 | Dry | 66 | 67 | Moist | 65 | 67 | Wet |
| G | 70 | 73 | Moist | 65 | 69 | Wet | 61 | 62 | Wet |

---

| | 4 | | | 5 | 6 |
|---|---|---|---|---|---|
| | Temp | | | Etc. | Etc. |
| | Sub | Surf. | Soil | | |
| Team H | 64 | 66 | Dry | | |
| I | 70 | 72 | Dry | | |
| J | 67 | 71 | Dry | | |
| K | 65 | 68 | Dry | | |
| L | 69 | 71 | Dry | | |
| M | 68 | 72 | Dry | | |
| N | 70 | 71 | Dry | | |

Have each team enter their temperature measurements and their estimate of soil moisture. Have them keep their observations of the characteristics of the locations for later discussion.

Average the soil temperatures for each location. You might want to discuss the value of averaging the results of several measurements to eliminate extreme differences which could be accidental.

Discuss any relationships between temperature and soil moisture which might be evident. Discuss relationship between temperatures and other location characteristics. If the coat hanger count was made, discuss the possible relationships of temperature to this previous survey. Try not to come to any definite conclusions. Reserve conclusions until after gathering further data from the more complex field activity.

# TRANSECT STUDY

## III. Pre-Activity — Measuring the Wind

Objective: 1. Measure wind velocity with a simple device.

2. Find out that wind varies at different times in different locations.

Materials: thread
plastic rulers
paper
pencils
simple, mimeographed map of the school grounds showing general shape of the building and major land-marks

Procedure A — Wind Strength

1. Problems for each student to solve are:

   a. Where are the strongest winds?

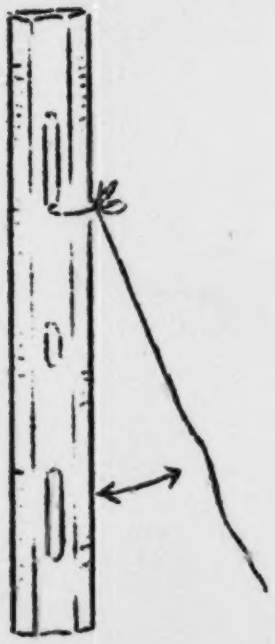
   b. Where are the weakest winds?

   c. Is the wind different at different times of the day in the same location?

   d. Is there more wind two feet above the ground than six inches above the ground?

In order to predict answers to these questions, it will be necessary for the students to come to the realization that wind speeds are related to the physical surroundings of an area. Measurements of actual wind speeds will provide the patterns that enable them to see these relationships.

2. Give each student a ruler and a piece of thread about 12 inches long. The thread should be tied near the top of the ruler. Cut off any thread that hangs below the ruler. When wind blows the thread, the thread will make an angle with the ruler and this angle will vary with the strength of the wind. Be sure the ruler is held straight up and down. If the thread is curly and doesn't hang straight down, it can be rubbed out straight with a small amount of light weight oil such as cooking or lubricating oil on the fingers.



3. Have students take their wind gauges outside and find the areas with the most wind and the least wind.

4. Return to the classroom and look at a large map of the school grounds drawn on the board and discuss where the different measurements were taken.

5. After this first discussion go out and mark about 20 locations around the school grounds where wind measurements will next be taken. These spots can be marked with white rags tied to sticks, or papers stuck to the ground with popsicle sticks or nails. Each location marker should be numbered so that the location can be identified on the map or on a large wall chart.

6. Have each student take a piece of paper and a pencil and their wind measuring device. They should now go outside and draw the angle that the wind makes on their wind gauge in each of the marked locations. This time, for each drawing, record the number of the location and describe the location. For example, "under a bush", "in an open field", or "beside a building."

7. Return to the classroom and compare the data. Place wind angles that are the same in piles. Then compare the locations that have the same wind velocity. The children will probably discover that the areas with the least wind speed have the most obstructions and visa versa.

Procedure B — Wind Direction

1. Give each student a map of the school grounds and have them take their wind gauges around to different locations to record the wind direction.

2. At each location, observe the direction in which the thread is blowing. Mark the location and indicate the direction the wind is blowing the thread by putting an arrow on the map at the appropriate place.

3. Bring the materials back to the classroom and transfer the data to one large map. Can you figure out some possible explanations for the differences in wind direction?

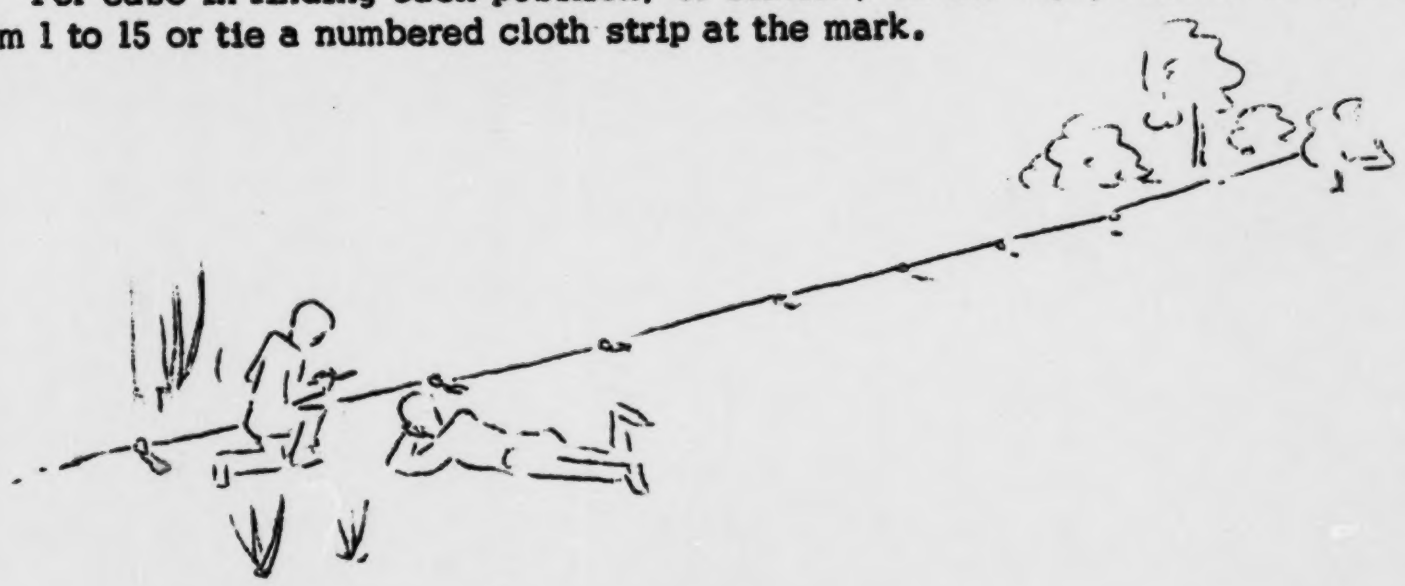
# TRANSECT STUDY

## IV. Pre-Activity — Materials to Prepare for the Transect Study

### Transect Rope

Use a 150-foot (60 meter) clothesline rope (or several ropes tied together). Give a group of students water-proof ink or water resistent colored tape to mark their ropes. Have them make a mark on the rope every ten feet (4 meters). At each of these positions a team will take samples of plants, insects, etc. when on the field trip.

For ease in finding each position, or station, on the rope, number the markings from 1 to 15 or tie a numbered cloth strip at the mark.



### Ozalid Paper

Cut and staple together stacks of ozalid paper. Keep the yellow side up. These stacks need not be over ten sheets thick. The individual sheets can be about 1" x 1". This must be done in very dim light and kept in the dark while transporting them to the field trip area. There should be one stack for each team. Each team might keep their stack of ozalid paper in a pocket until they expose it on their transect. (See materials list, page 27 for ozalid paper sources.)

### Data Sheets

Prepare data sheets similar to those on the following pages before the site study. Staple plastic sandwich bags to the sheets so the top of the bag is open. Use the plastic sandwich bag with the fold lock top. Staple the bags to the data sheet so the top can be flipped forward to hold in the materials the children collect.

Transect # _____ DATA SHEET #1 Name _____

1. Temperature — morning

   a. surface temperature _____
   b. ground temperature (3 cm down) _____
   c. sub-soil temperature (20 cm down) _____

2. Take one sample of each type plant found within sample area

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

Transect # _____ DATA SHEET #2 Name _____

3. Pick a twig or leaf from each type of plant which is <u>taller than your knees</u>, <u>but shorter than you are</u>. These must be touching or hanging over your transect section.

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

4. Take a twig or leaf sample from each type of plant which is <u>taller than you are</u>. These must be touching or hanging over your transect section.

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

( attach bag here ) Total No. of Plants _____

Transect # _____ DATA SHEET #3 Name _____

5. Temperature — afternoon

   a. surface _____
   b. soil _____
   c. sub-soil _____

6. Soil sample (handful put in bag)

   a. soil 3 cm down

( attach bag here )

   b. Soil 20 cm down (or half way to your elbow)

( attach bag here )

Transect # _____ DATA SHEET #4 Name _____

7. Soil Moisture, What Is It? _____

   a. Dry — falls apart and sifts between fingers.
   b. Slightly moist — appears moist but does not stick together when squeezed.
   c. Moist — sticks in a clump when squeezed.
   d. Very moist — squeeze and the water is obvious.
   e. Wet — water drips.

8. Ground insects (pick up with fingers) Add a small amount of alcohol to bag.

( attach bag here )

9. Insects on plants (make ten sweeps with the net) Add a small amount of alcohol to bag.

( attach bag here )

Transect # _____ DATA SHEET #5 Name _____

10. Wind (sketch of angle)

a. on the ground

b. at waist level

c. above your head

11. Light intensity — No. of faded sheets _____

# TRANSECT STUDY

## V. At the Field Site

Objective:
1. To obtain data from field measurements for later use in discovery of natural relationships.
2. Gain direct experience with using tools and techniques in ecological study.
3. Gain direct experience with a relatively undisturbed natural area.

Materials:
marked clothesline rope
insect net (see appendix for pattern if you must construct them)
plastic sandwich bags
strong spoon or garden trowel
thermometers
ozalid paper packets (ozalid paper is available from engineering materials supply firms)*
pencils
data sheets
wire ring for sampling (or coat hanger)
commercial grade ethyl or isopropyl alcohol (obtain from paint or hardware store)

The following time schedule was set up for the site study:

| | |
|---|---|
| 10:00-10:15 | Arrival (rest stop and assembling) |
| 10:15-10:30 | Orientation, instructions, equipment handout |
| 10:30-11:30 | Morning studies (light intensity, temperature, moisture, plant samples) |
| 11:30-12:00 | Lunch |
| 12:00-1:00 | Afternoon studies (insect samples, temperature, soil, wind) |
| 1:00-1:30 | Organization of data on chart (included in post-activities, but easily done in the field if weather permits) |
| 1:30-1:45 | Discussion of data |
| 1:45-2:00 | Cleanup, rest stop, loading |

This schedule may be adjusted to fit the situation. The stated time periods allow for adequate completion of the activities included in the following field trip description plus completion of the data chart and accompanying discussion found in post-activities section. If display and discussion of data is held on the field site, the data sheets may be partially completed in the morning and discussed at the noon break. The rest of the data is then collected in the afternoon and the display and discussion of relationships is continued in the classroom according to the post-activities.

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*Ozaiid paper can be ordered directly from General Aniline and Film Corporation, 140 W. 51st Street, New York, New York, 10020

This schedule allows time for transporting students to and from a field site for a full day's activities. A half day field trip could be planned if the completion of the data sheet and its discussion were held in the classroom.

A. Organizing the Study

Divide your class into teams of two students each and assign each team a station at ten-foot intervals along the clothesline rope. This will be their station for study. All tests, examinations, and samples will come from the immediate location of their station on the rope. The information for all the stations will later be brought together to study the transect as a whole.

B. Locating the Transect

The most desirable location for a transect study is across an area of change. For example, from a wet area to a dry area, from a low area to a high area, from an open field into a woodlot, or from a sunny area to one constantly shaded. If it is not possible to locate in an area of change, the transect still forms a worthwhile tool for handling a study of a somewhat homogeneous area, e.g. an open field.

C. Setting up the Transect

Once the area is located, extend the rope across the area in a straight line. You might stake or tie down the ends of the rope. If you are running the transect across an area of change, start from the farthest point you wish to study and extend the rope across the changing area.

D. Studying the Transect

Light Intensity

The placing of the ozalid paper for this activity should be the very first concern of the day. As suggested in the preliminary activities, the packets of ozalid paper should be transported to the field trip area in light-tight boxes. When each team receives their packet they should try to keep it from the light as much as possible until they place it at their transect station. These packets should be the last item passed out, but the first used. To allow adequate exposure time, the packets should remain at the station until the study is concluded. Perhaps a signal such as a whistle could be used at which time the teams would collect their packets and count the faded pages. A two-hour exposure is about right on a sunny day.

To place the packets each team may select some typical location near their station, and lay the packet at ground level with the yellow side facing up and horizontal to the ground. Hold the packet down with small stones or sticks on the corners of the packet. Don't shade the paper with these objects!

When the time comes to count the faded pages of the packet, all the teams should do so at about the same time. The sun shining on the packet will fade the yellow from the first page, then the second, etc. Fractions of pages can be discerned so a team may find several pages completely faded and one page where the yellow is only partially faded. However, fractions other than 1/2 and 1/4 are too difficult to differentiate so ask the students to approximate either a page that is completely faded, half faded, or quarter faded.

Temperature (morning and afternoon)

Each team receives one thermometer and a spoon or garden trowel. They should select a spot on their section of the transect to take the surface, soil, and sub-soil temperatures.

The surface temperature is taken by laying the thermometer bulb up. Wait until the fluid stops moving and record the temperature in the appropriate section of the data sheet.

The soil temperature is taken by first shoving the handle of the spoon into the soil and wiggling it to make room for the thermometer. The thermometer is then inserted into the hole about 3 cm down and the soil shoved back around it. Wait until the thermometer has had time to adjust (approximately three minutes). Scrape enough soil away to read the thermometer while it is in place. Record the temperature in the appropriate section of the data sheet.

The sub-soil temperature is taken by digging a hole deep enough to reach half way to the student's elbow. The temperature is then taken in the same way the soil temperature was taken, only at the bottom of the hole. Record this temperature in the appropriate section of the data sheet.

Moisture

The directions for the moisture determination are included on the data sheet. Each team determines the moisture for a typical spot on their section of the transect. This is recorded on the data sheet.

Plants

a. Surface cover plants

Each team should place their wire ring or coat hanger so that it touches or crosse the transect rope close to their station. They may then collect one sample of each different type of plant found within the wire. Each plant is placed in a separate bag in its appropriate spot on the data sheet.

When all the different types within the wire are located, each team should count the numbers of that type found within the wire area. This number is recorded next to the bag containing that plant.

b. Shrubs, bushes, etc.

Each team should remove one leaf or twig from each different type of plant which is higher than their knees but shorter than they are tall. These plants must be over-hanging their section of the transect. These are placed in the appropriate bags on the data sheet. Write the number of the kind of plant beside the bag containing the sample. For example, a bush would be called one plant.

c. Trees and tall bushes

Remove one leaf or twig from each type of tree or bush that is taller than they are tall and over-hangs their section of the transect. Place these in the appropriate bag on the data sheet. Write the number of this plant beside the bag containing the sample.

Insects

Provide each team with two plastic bags containing 1/8 cup alcohol each.

a. Sweeping (for insects on plants)

Have the teams sweep their section of the transect with an insect net. To "sweep", the children should extend the insect net with the opening sideways. They should swing the net across in front of their body, turn the net and swing it back across in a figure eight. At the low loops of the figure eight the net should brush down the vegetation. The children should take a few practice swings so they don't hit the ground too hard or swing too high.

When they finish sweeping with ten swings they should grab the neck of the net a few inches from the bottom and close it off so no insects can escape. The section of the net containing the insects is then inserted into the bag containing alcohol. Get the net wet with alcohol and hold the net and killing bag in this fashion until you count to 200. The insects can now be removed or dumped into the appropriate bag attached to the data sheet. Add a small amount of alcohol to the data sheet bag.

b. Searching (ground insects)

Have the children place the wire ring on the ground so that part of it lies on or under the rope. They may now carefully search the area enclosed within the hanger for insects. As they find them they should drop them into the killing bag. Leave the insects in the killing bag for several minutes. Remove the insects and place them in the appropriate data sheet bag with a small amount of alcohol.

Soil

Using the spoon or trowel, clean away the surface material and collect a handful of soil from the surface (3 cm) and put it in the appropriate bag on the data sheet.

Dig down to a depth reaching half way to the student's elbow (20 cm) and take a second sample. Place this sample in the appropriate bag on the data sheet (the hole dug for the sub-soil temperature reading can be used).

Wind

The wind reading is taken and recorded in the same manner as used in the preliminary wind activity (see page 19). The recording is made on the data sheet. The wind may vary as the children check at different levels above the ground. The data sheet has places for recording wind at three different levels.

# TRANSECT STUDY

## VI. Post-Activities

Studying the great quantity of collected data can be a frustrating procedure. Organization of the class is the key to coming up with some meaningful and valid conclusions to the study. If organization is left at the class discussion level, there are several pitfalls which may occur.

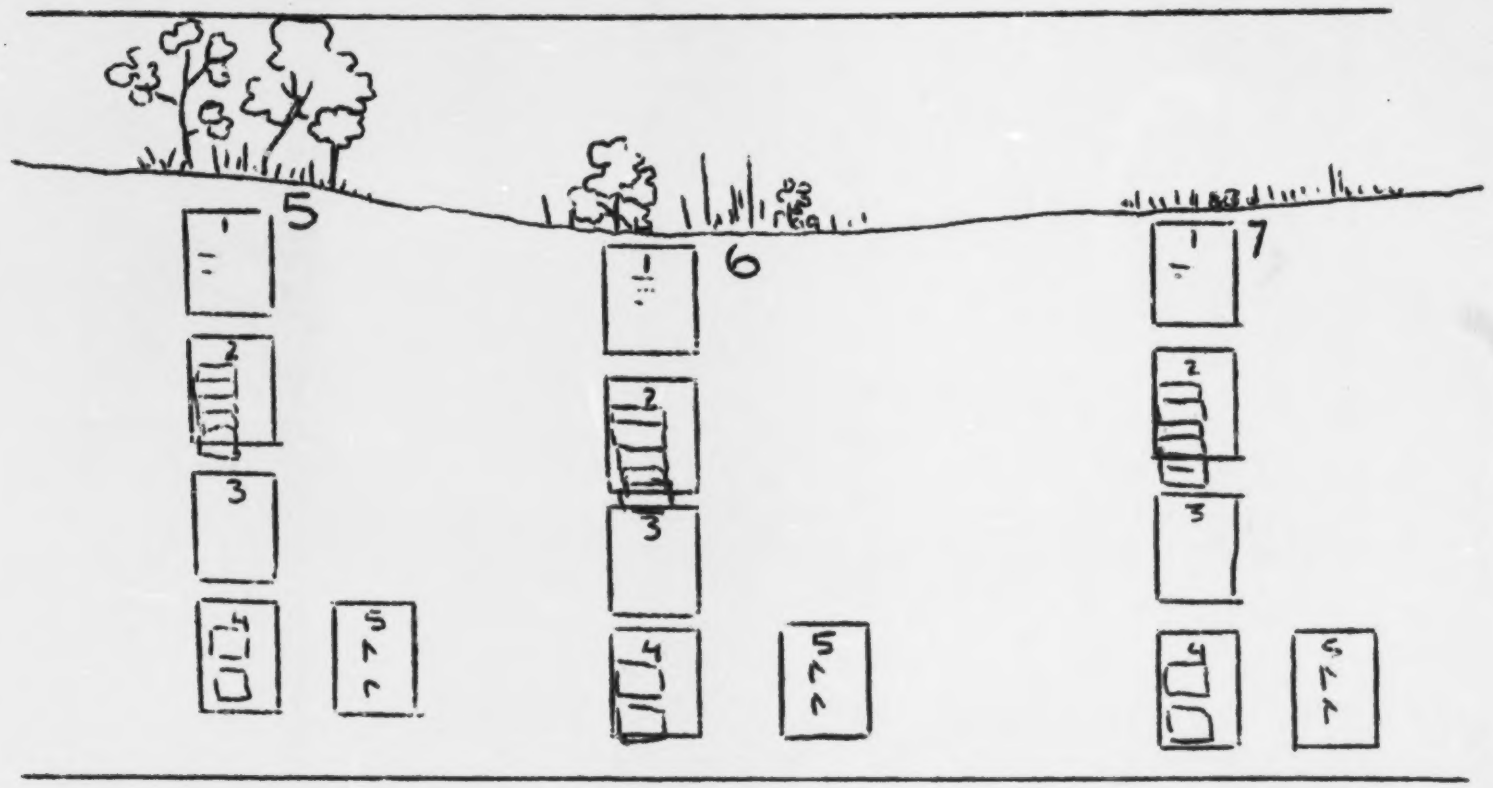
One of these is "steering" the class into "discovering" certain relationships. For example, "might the great amount of bushes at this transect station account for the slight wind?"

Another pitfall is finding certain relationships and calling them valid without supporting this conclusion with other data they have collected. For example, one type of plant exists only in a section which has the highest moisture content. The conclusion is drawn that that plant only exists where there is high moisture. However, there are other factors which must be considered. Has the light intensity been considered?...the temperature?, etc.

A final pitfall is that class discussion technique does not stimulate every child to think and contribute his ideas. To avoid the above, the following outlined procedure for studying the collected data is suggested.

A. Display chart (long, segmented line representing the transect stations) (Some relationships between transect stations will be noted during these activities.)

1. Each team draws the vegetation of their transect station on the display chart (trees, bushes, etc.)
2. Each team attaches their data sheets below their station number on the transect chart.



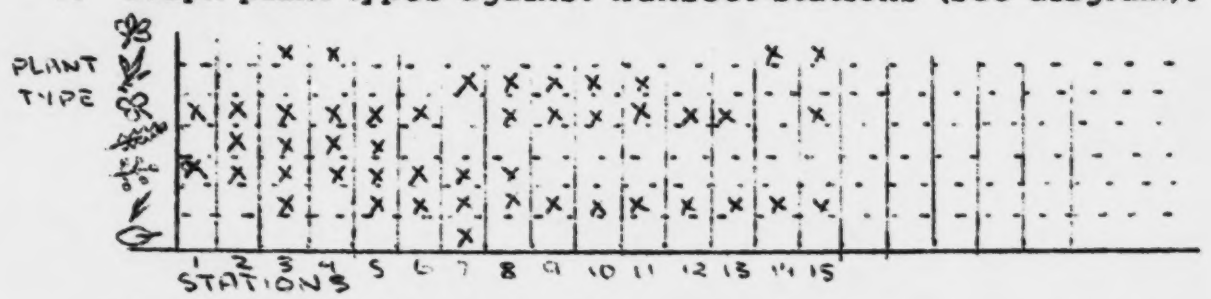
B. Brief class discussion to look at the display chart as a whole (This discussion should be brief and may be opinionated and not supported by fact. A and B may be concluded on the field trip.)

1. Are all the transect stations alike?

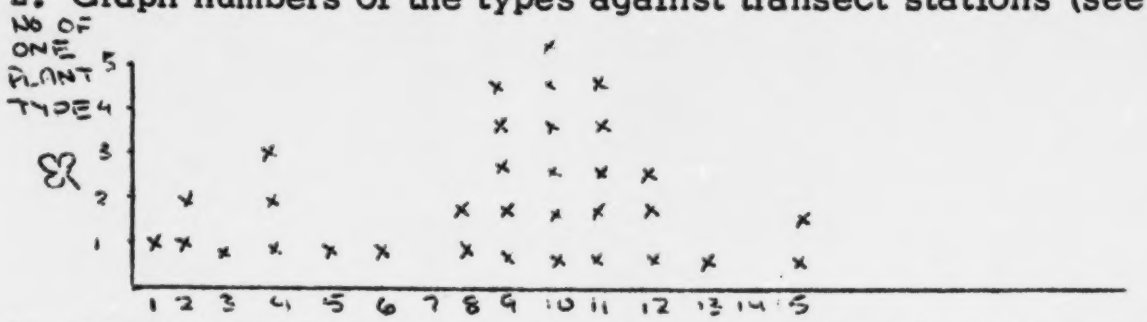
2. Note similar transect stations and very dissimilar transect stations.

C. Class graphs of plants and animals (see page 4 for insect preparation) (Similarities and differences will be more apparent by such a display. Students will be able to more easily study the factors causing these similarities and dissimilarities.)

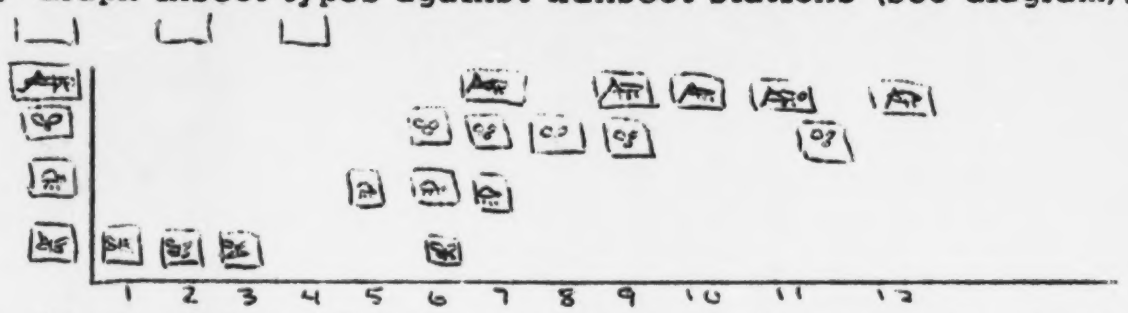
1. Graph plant types against transect stations (see diagram).



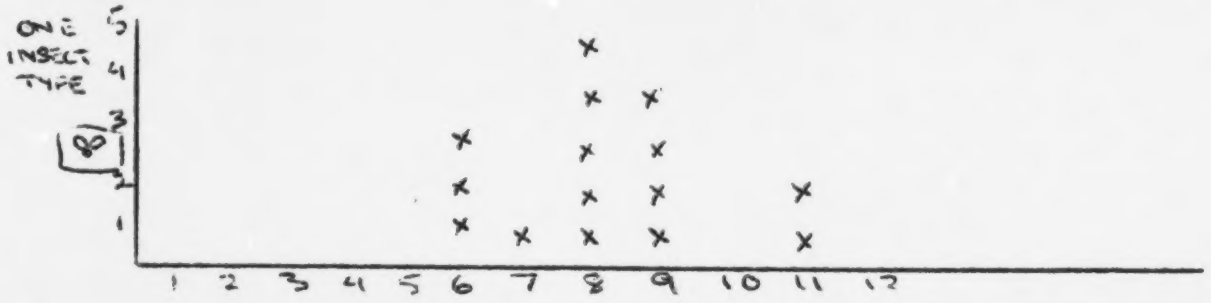

2. Graph numbers of the types against transect stations (see diagram).




3. Graph insect types against transect stations (see diagram).




4. Graph numbers of the insect types against transect stations (see diagram)



D. Account for the results of the class graphs

1. Organize the class into groups of two teams each (four students).
2. Have each group prepare a list of suggested reasons for the similarities and dissimilarities found in the class graphs (C).
3. Combine these lists on the board. This list will probably include factors such as light intensity, temperature, etc.
4. Assign each group one or two living things (plant, insect). Ask them to study the distribution of their assigned living thing along the transect. What factors from the list helped determine the distribution?
5. Each group prepares a statement complete with <u>data supporting</u> their conclusions drawn from the class collection of data.

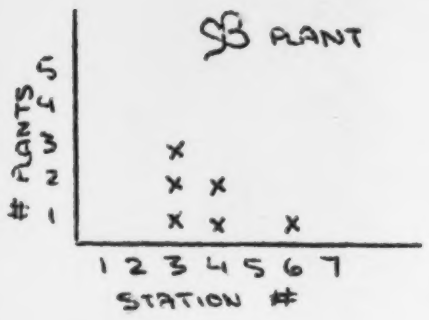
Encourage the children to make graphs and visual displays as often as possible to support their conclusions. However, many teams will make only intuitive judgments. Encourage them to see the supportive value in taking data from the display to validate their opinions.

Following are two examples of results which may occur within the same class. The first is an extremely simple statement. The second is a very complete statement.

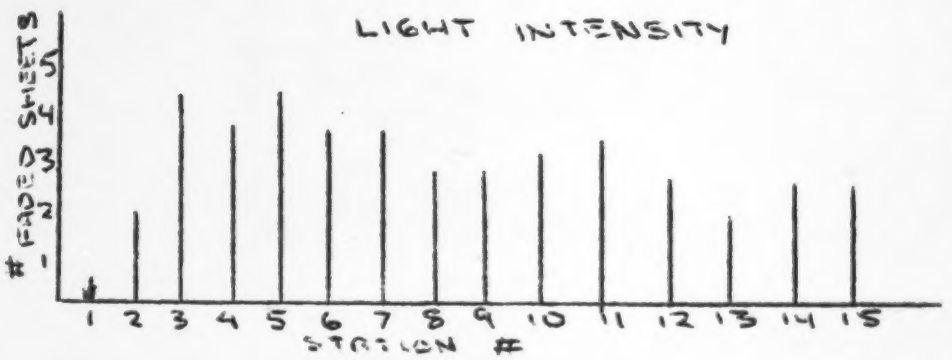
1. "We found our flying insect at stations 7 and 8. There was no wind recorded for station 7 and 8. This insect probably likes very still air."
2. "A three-leafed plant was found only at station 3, 4, and 6. We looked at the light intensity, temperatures, soil, wind, and moisture on the large display and, based on these graphs, we decided that the distribution of this plant probably depends mainly on moisture and light intensity."

   "The soil could not be graphed, however. The surface soil remained the same throughout the transect so we could not consider this as a determining factor."

   "Notice that the combination of slightly moist soil and high light intensity are the only two factors that are the same for intervals 3, 4, and 6. Neither of these factors could be the lone determinant (see graph #2, section #1, and graph #3, section #7). We cannot explain why #5 does not contain this plant as it has slightly moist soil and high light intensity. Perhaps the sampling did not include this plant."

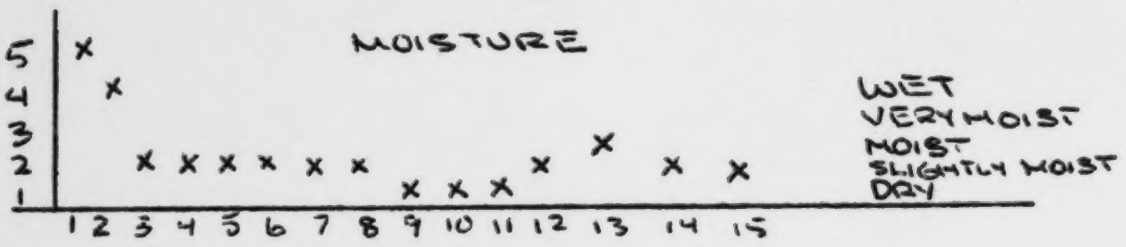



GRAPH 1.

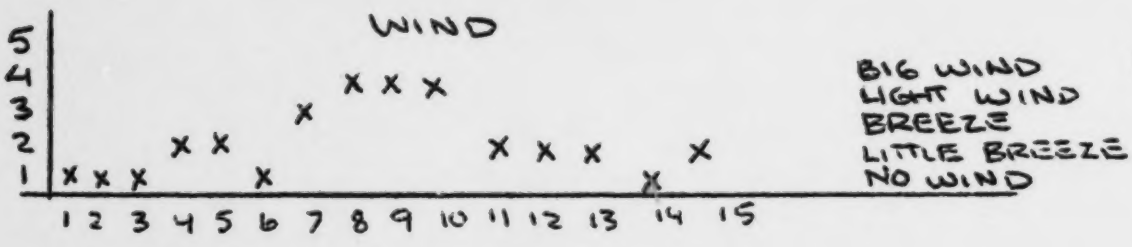



GRAPH 2

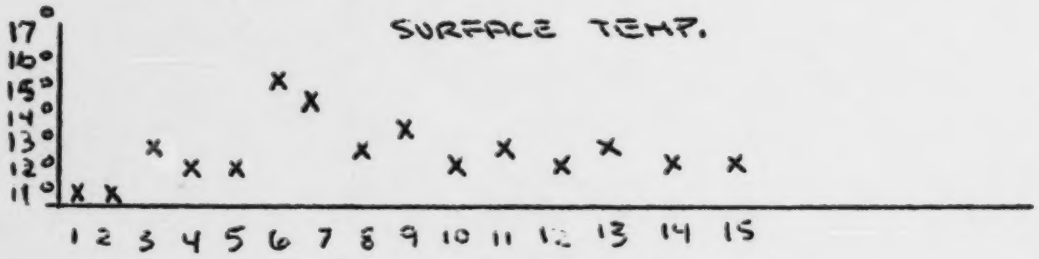
GRAPH 3



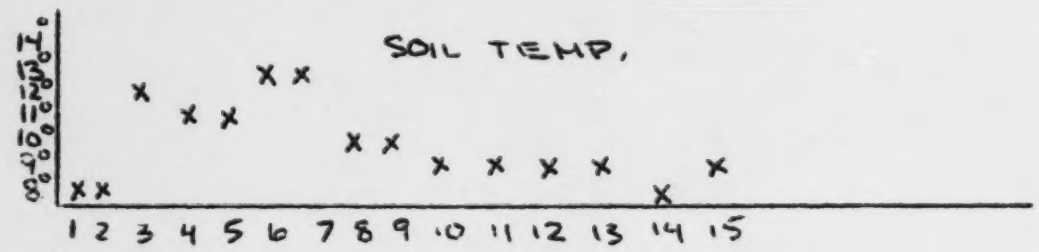

GRAPH 4




GRAPH 5




GRAPH 6




Often a group will need a question to get them started. Following is a list of questions, one or two of which you may need to use to start a group thinking. You may wish to read through the questions to orient yourself to the great number of possible investigations the groups might pursue. It is not intended that you use all these suggestions.

Temperature

Which of the three temperatures (surface, soil, sub-soil) is generally the warmest?

Are there any stations at which the three temperatures (surface, soil, sub-soil) are almost the same?

Looking along the transect, where does the surface, soil, or sub-soil temperature vary the most between stations of the transect?

Are there any significant changes in temperature from one station to the next? Does this change show up in the surface, soil, and sub-soil temperatures?

Is there any progressive change in temperature over three or more transect stations?

By looking at the collected data can temperature be considered as a determinant of numbers and types of life? Can they find some patterns of temperature and life number or types? Is there a certain ground bug found only at the warmest transect stations? Is there a certain type of plant found only at the coolest transect stations? Do the numbers of a certain type of plant or animal seem to change with temperature?

Make sure the children do not draw the false conclusion that temperature is the lone determinant. Moisture, light intensity, etc., may also effect the distribution of life. In fact, the temperature itself is a result of many factors such as moisture and light intensity.

Light Intensity

As with the temperature readings, guide the students toward a discussion of whether the light intensity at different stations varied at the same time that some other factor varied. Were there waist-high or over-head plants present on some transects and not on others?

Soil

Examine the display for different types of soil. Can they think of any reasons why different types might exist? Can they find a progression from one type of soil to another? Does the sub-surface soil vary as much as the surface? Do the types of vegetation change with the soil?

Is the surface soil different from the sub-surface soil in some cases? Is it the same in some cases? Can the class decide anything about the depth of the surface soil? If the depth seems to change can they think of any reasons for this happening? Does any other factor change when the soil changes? Which is dependent upon the other. Is there any way to prove this?

Wind

Does the force of the wind vary much along the transect? Are there physical obstructions or land characteristics which change as the wind velocity changes along the transect?

Does there seem to be a relationship between amount of wind and air insects?

Is there a relationship between amount of wind and temperature?

Is there a relationship between amount of wind and moisture?

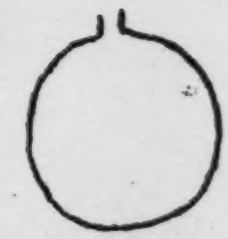
Moisture

Is there a possible relationship between moisture and a plant type or numbers? ...between moisture and a ground insect type or numbers of that insect?

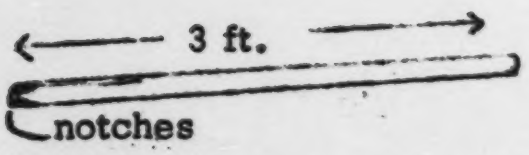
Why are there different amounts of moisture? Is there a possible relationship between moisture and light intensity?...between temperature and moisture?

## APPENDIX

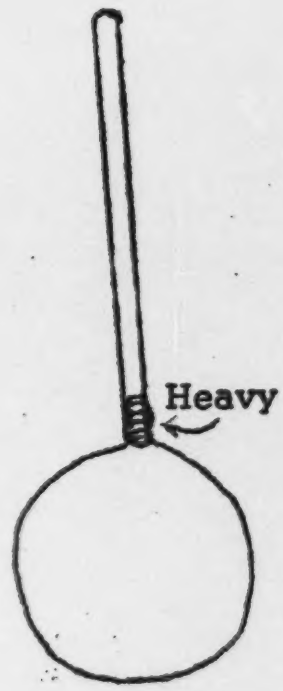
### Insect Net

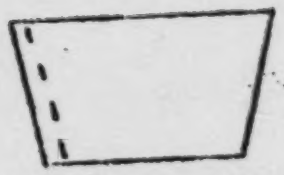


Bent Coat Hanger



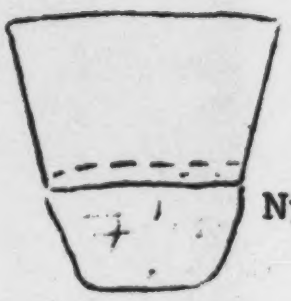

Dowel notched on two sides

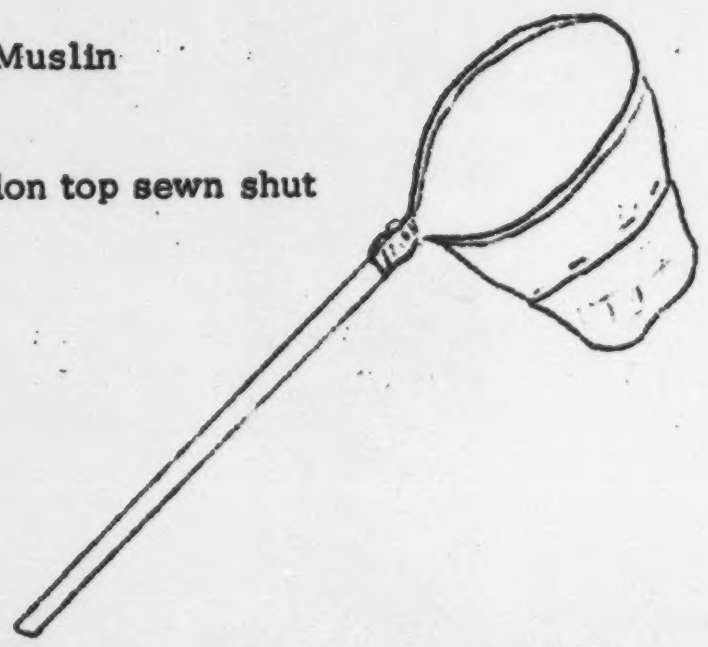


Muslin or old sheet
(two pieces) sewn together

Top from nylon stocking



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EDO 42635

# TRANSECT ACTIVITIES I

Environmental Science Center
5400 Glenwood Avenue
Golden Valley, Minnesota
55422

SE 009 749

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B.B.C. 6/4/68

# PREFACE

The idea that man is ultimately dependent upon the natural resources of this world for his continued existence upon it is acknowledged by most but understood by few. Seemingly our resources are unlimited; vast quantities of land are as yet uninhabited, two thirds of the world is water, and our air supply is continually replenished through the process of photosynthesis. In short, the global picture is apparently encouraging; it is unthinkable that man could possibly deplete his resources to the point where his very existence is threatened. But there is now evidence that man is doing just that. That evidence is testimony of man's misunderstanding of his effect upon his environment both short and long range. This, in turn, implies that he has failed to recognize the limited ability of the environment to recover from the shock of increasing industrialization and waste production.

Man's efforts in the area of conservation have not been consistent; the variety of conservation organizations suggests that the word means different things to different people. Thus, attitudes toward conservation are observed to be emotional as well as rational and sanitive depending upon the nature of the organization. Because diverse conservation groups have diverse concerns, the crucial issues are often clouded by differing, sometimes antithetical, but tenaciously held interests. How, then, may the public sort out the emotional from the rational, and be brought to the point where it is capable of making judgments which could well effect its own destiny?

We feel that indifference, lack of understanding, and inaccurate knowledge can in part be erased through education. While it is true that conservation has been a part of most school curricula, it is increasingly apparent that attempts at changing attitudes have made little impact on society. The fault lies with both the educational system and the conservationists. Instead of involving children in activities designed to uncover the scientific basis for conservation practices, we have taught children conservation technology. Few of them will ever have the opportunity to practice that

technology. Thus, such activity is a remote experience for them. Yet, the underlying science — the ecological relationships — can be significant learnings for all. Regardless of man's personal habitat — city or farm — he needs to understand his relationship to and his effect upon his environment. Only when he is equipped with utilizable knowledge will he act upon it to reverse or halt the destruction of his own habitat.

In response to the lack of well informed individuals capable of making decisions about the future quality of our environment, the Environmental Science Center is devoting its energies to the development of new instructional materials designed to provide teachers with activities which will bring children either directly or indirectly into a confrontation with their environment. Through direct and significant experiences with their environment, it is hoped that children will begin to incorporate into their expanding body of personal functional knowledge those processes and concepts appropriate to the science of ecology.

To, in part, achieve this end, the material contained herein is presented as a series of suggested studies which are felt to be of the type which will cause children to become actively involved with the "things" of their environment. Although the activities can be viewed as essentially unrelated to one another, and can indeed be used in this fashion, they are tied together by the idea that each should be conducted in a systematic way. This is accomplished by first defining observation limits, then planning for and organizing the activities within the limits of investigation procedure. A more complete discussion of limit definition follows in the BACKGROUND to this lesson.

This booklet is intended to be used primarily by those individuals whose preparation in ecology has been sufficient for implementation of the activities. This does not mean that others could not derive benefit from it. In its present form it is not viewed as implemental material although a general procedure has been described which provides the reader with some ideas of how to introduce the activities to the children. The booklet, then, is to be treated as a handbook which details those activities which are felt to be most manageable by students and teachers alike.

## BACKGROUND

Few teachers, especially elementary personnel, have had the opportunity or background necessary to engage their students in a productive inquiry into the environment. Most teachers, confronted with the desire to study the natural environment for the first time, are struck by the massive amount of natural materials and the lack of a method for its systematic and manageable explanation and organization. While each brings to the situation a certain degree of knowledge about the environment — usually in the form of unrelated facts or information not readily applicable to field study — this knowledge is not of the type useful when causing students to begin an inquiry into their surroundings.

Given the common sense knowledge of the teacher and her willingness to participate, certain ecological procedures for systematic study can be learned and in turn used with children in a fashion similar to the way in which it was taught to the teacher. Essentially, the procedures have to do with sampling methods. Since it is impossible to count, describe, label and categorize everything one observes in the field, ecologists employ sampling methods designed to limit their observations to only <u>manageable units</u> of a larger area. Manageable units take many forms and sizes; thus they are not particularly standard. For example, suppose your class wishes to study a vacant lot next to the school. They could study the entire lot, or portions of it. If they were investigating soil micro-organisms it would be a near unending task to study all the soil. But they could select <u>sample plots</u> — smaller units within the lot — and derive data from which generalizations about the entire lot could be drawn. On the other hand, if they wished to determine what percent of the lot was covered by trees, they could probably study the entire lot without difficulty. In this latter instance the complete lot is still referred to as a sample plot, even though it is a much larger unit than the micro-organism sample plot. The rea- for this fact is that one can never study the whole of the biotic world; thus everything short of the whole is a sample of it.

Sample plots are usually square in shape, or rectangular, but they need not be. The important factor is that once the size and shape of a plot is decided upon each student or team of students should work witin those prescribed limits. Uniformity of procedure in part assures that data derived from one plot may be compared to that derived from another as long as the object of the study does not vary.

Another sampling technique is based upon collecting data along a line. This line, called a transect, is arbitrarily layed out through a natural area which holds interest for the investigator. Perhaps it is an area marked by changing vegetation types or perhaps the vegetation is comparatively uniform. Whatever the purpose for the investigation, a line is "drawn" and sampling is done at equal distances away from the line along its entire length.

A variation on the transect theme is the quadrat method of sampling. Again, a line is drawn" but instead of sampling at equal distances away from and along the line, alternate areas on either side of the line are sampled. Below are diagrams of the three types of study methods described above.

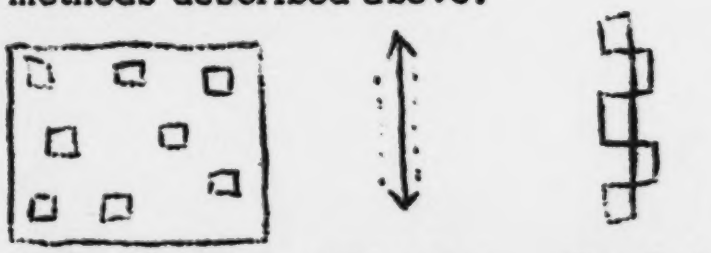



Figure 1. Organizational plan of three study methods.

During the course of the development of the science called ecology, scientists have derived increasingly sophisticated sampling methods. Some apply to only specific types of investigations, while others have more general application such as those already described. For example, one could measure a timber stand for the possible number of board feet in that stand by using a plot study technique. All trees within the plot could be counted, the circumference of each could be measured, and, throughtthe application of scientific formulae, the investigator could arrive at a good estimate of board feet. This method, as described, is time-consuming. Foresters now use a device called a Biltmore stick in combination with another complex technique to reduce the task to a more manageable one which does not involve sampling all the trees.

Regardless of the sampling methods and techniques employed, the intent is always the same: to investigate an area using a method which makes the investigation manageable for the inquirer while still yielding significant data collected systematically.

We have chosen the transect technique as that which will probably have the most import for both teachers and students. It was felt that both groups could easily grasp the usefulness of the technique and would have minimal difficulty with its implementation. The most elementary procedure to follow would begin with students identifying an area they wish to study. Next they should determine what they want to find out about that area. Then a representative substitute should be selected in order to limit their investigation to manageable proportions before they finally choose the place to stake out their transect line.

The next section of this booklet indicates some useful procedures and strategies for causing children to become involved in the activities presented herein. It is not necessary to proceed as indicated in the background section if you have extablished procedures of your own and have found them workable.

## GENERAL TEACHING PROCEDURE

As stated previously, this booklet will describe a variety of investigations which can be done as part of general field work in ecology. Each activity or investigation is different. Each is a means -- a technique -- for the study of a single facet of the environment. In this sense, the techniques are unrelated to one another. Relatedness develops through organizing each investigation around a central theme -- the transect. A transect is a method for standardizing sampling procedures. As its name implies, it is a line which cuts across an area. This line, once established, serves as a guide for the investigator. His observations are made along only that line. Through establishing a number of transects on a field study site, the site can be adequately sampled in a systemmatic way.

Students should be concerned about systemmatizing procedures. You will want to stimulate concern by first involving them in some preliminary activities designed to (1) raise questions about why things <u>are</u> as they are and are <u>where</u> they are; and (2) focus attention on the procedures for obtaining answers to their questions.

One way to begin would be to use the Environmental Science Center lesson, 'Variation Within A Species'. This lesson involves children in activities designed to expose them to the fundamental concept of biological variation and further to the idea that variation is the basis for evolutionary change. If all biological entities were inherently unvarying, no change or modification in structure or function could have taken place with time. The variation lesson concludes with the suggestion that children continue their investigation by studying how plant forms may be modified by changing environmental conditions. Here the children would present ideas about what factors could be studied to reveal the affects of the environment on plant appearance. More sophisticated studies might involve them in plant genetics problems. These latter studies are perhaps too complex for most elementary students, but certainly follow logically the work begun in that lesson. A knowledge of variation, then, should precede any preliminary work designed to account for variation. Should you choose not to do the entire variation lesson, modify it in the following way: Select a reasonbly large study site on or near the school grounds where the children may eventually run their transects. Search the area for a single type of plant which occurs with some regularity over the site. Collect <u>whole leaves</u> from the plant and place about ten leaves in each of some twenty-five or thirty plastic bags. The number of bags prepared should correspond to the number of students in your class. When you have collected the leaves, present a bag to each student and ask him to observe the leaves. Ask several students to describe them to you and list their descriptions on the board. Not every child will describe them in the same way. Some will say they are small, some will maintain they are large while others will suggest both sizes exist. Continue the description process until it becomes apparent to the class that the leaves vary in many of their characteristics even though each leaf is the same <u>type</u> as each other leaf. (This, they must agree upon.)

The purpose of this simple exercise is to cause the children, through observation, to recognize biological variation. You may extend the experience using other plant material, examples drawn from the animal world, or by causing the children to notice variation among class members.

Once they have grasped the idea, return to the initial plant material and ask them to suggest reasons for its variability. Here you will want them to suggest some of the possible environmental factors (soil, moisture, climate, etc.) which could affect plant form. After a list of factors has been established, ask them to think of some ways whereby one factor might be investigated. Allow them sufficient time to discuss the problem among themselves and with you. When you see that ideas are beginning to emerge, suggest that each try out their ideas. Refrain from injecting your own thoughts. The students should be permitted the freedom to draw upon their own resourcefulness and assume the full responsibility for the conduct of their own investigations. Set aside time and indicate the study site as the area for investigation. (This will be the site from which the plant material was removed.) Encourage them to develop their own equipment if needed and to also develop their own specific modes of investigation.

No doubt many investigations will be conducted in a rather haphazard manner. This is to be expected because children are apt not to be systemmatic. Some investigations may appear to be pointless -- a waste of time -- yet, unless given the opportunity to make mistakes many students will never be convinced of the efficacy of planning, organizing and systemmatizing their work. Your role in this process is to assess the practical feasibility of the investigations and to provide the climate wherein freedom to pursue an idea assumes greater importance than the idea itself.

It will be frustrating and perhaps chaotic for both you and the children, but the ends will no doubt justify the means necessary to reach them. That is, the children should have rather firm convictions about systemmatizing their studies before pursuing additional work.

When each child or group of children concludes his investigation you will want them to share their experiences with one another. Presumably the object of each study was to derive data on one environmental factor which might, in part, account for variation among plants of the same species. Whichever factor was chosen for investigation, discuss the results by asking the following or similar questions:

(1) How did you conduct your study?

(2) How many tests (experiments) did you do?

(3) What portion of the study site did your investigation cover?

(4) Were any measurements made?

(5) Were measurements recorded?

(6) What did you find out?

(7) Did others in the class obtain similar results? If not, can you account for the differences?

(8) Were you satisfied with the manner in which the study was conducted?

(9) What part or aspect proved to be most difficult?

(10) If you were to do a similar investigation now would you alter your method in order to improve it?

(11) How might you propose to better standardize and organize your work?

From a discussion based on the above questions these ideas should emerge:

(1) A large study site should be approached through proper sampling of it.

(2) Data should be organized and recorded.

(3) The procedure to follow should be standard throughout the class after it has been agreed upon by the class.

(4) There are more economic means of handling extensive investigations than those probably used here.

(5) Those means have to do with limiting one's study through proper sampling, thereby making a study more manageable.

(6) Once those means have been decided upon they should be employed by all class members hereafter.

The above series of questions and discussion points are by no means the only effective lines of inquiry to pursue. Remembering that the object of this preliminary study was to cause the class to see the need for systemmatic methodology, any line of inquiry which will bring them to this realization will do. A difficult but very crucial aspect of this discussion is to refrain from offering your answers as the children examine their experiences for their own answers. Thus, the atmosphere of this critique should be encouraging and thoughtful rather than discouraging or overly critical.

Once the class has agreed that there must be a more manageable way to study a complex situation, have them suggest some ways of limiting their observations while still "covering the territory'. You will now want to lead them to propose a "transect-like" idea. If no one suggests the line method, you might offer it as one alternative to others suggested. It would not be unreasonable to ask them to try this method since it is the most straightforward one. New problems concerning sampling -- how often, where, how many -- will now arise. Some guide lines for sampling follow:

(1) Sample as often as is reasonable depending on the density of the plants being sampled.

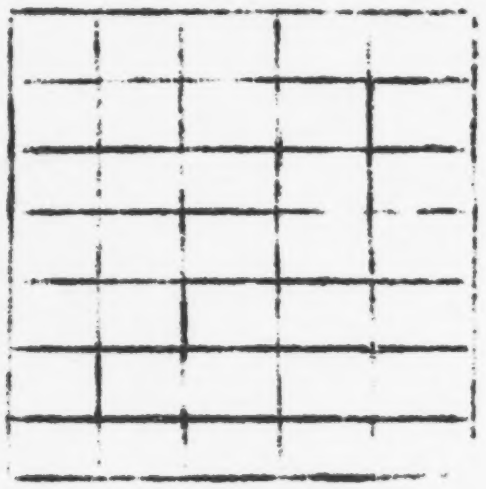
(2) Test as often as reasonable making certain that major areas of change are tested.

(3) Each group involved should do exactly the same thing. For example, if plants are to be sampled every three feet along a transect, all must sample every three feet. (This will be explained more thoroughly in the next section.)

(4) Record data according to where it was derived along the transect. Transect maps showing collection points are very useful.

In summary, sampling methods must be modified to fit a particular situation. You might find the most workable solution to your problem is to arbitrarily establish sampling points for the class, for example, every three or four feet along the transect. This decision may, in turn, be modified once the investigations are under way.

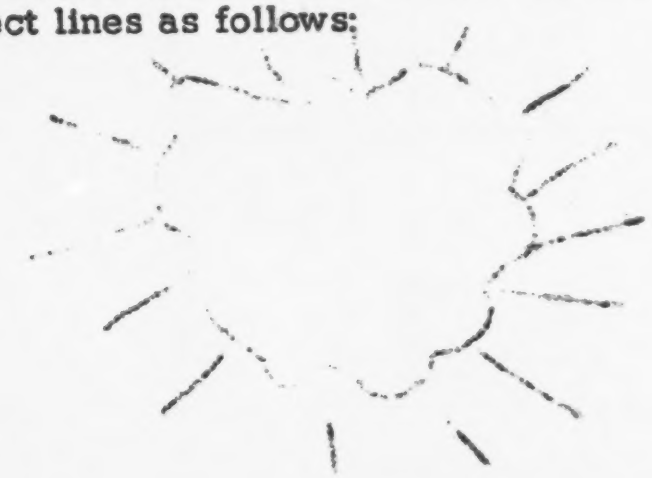
Finally, you will want to discuss where transects are to be laid out over your study area. If your site is relatively large and flat you might suggest a grid pattern as shown below:



Grid

Here, each line represents a single transect. The criss-crossing of a grid assures that the site will be well sampled.

If you have a pond or swamp on or near the school grounds you might wish to set out transect lines as follows:



The lines radiate out from the center much like wheel spokes. Interesting vegetation patterns occur in concentric circles around the perimeter of a pond. A radial plan for investigation will demonstrate these patterns. Data may be discussed in terms of distance from the pond's edge.

Ultimately, the design decided upon should result from class discussion. Transects can be laid out in any pattern chosen. The best pattern is that which transects an area of changing vegetation. These areas are of particular interest because they yield variable data. That data may eventually reveal reasons for vegetation changes. This, after all, is the object of the transect study. Once the transect sites are chosen any or all of the activities in the booklet may be done on each site. Student teams should plan to do exactly the same activity(s) so that their data may be compared. When the activities are computed, data should be discussed in terms of the transect position and in terms of changing vegetation types.

POOR ORIGINAL COPY - BEST
AVAILABLE AT TIME FILMED

# ATMOSPHERIC STUDIES*

Every process going on in plants and animals will proceed at a rate dependent upon many of the environmental factors. There is a combination of factor values that will re lt in the greatest speed of each of these processes. This can be ca d the optimum of these factors for a given process. Not all processe ave the same optimum; so the general development of a plant or an animal has an optimum composed of a compromise of all the separate optimums.

Each process also has a minimum and a maximum level of tolerance for each factor. If in an area any factor exceeds the maximum or is below the minimum, the plant or animal cannot live there. Although it is true that some factors can partially compensate for others, the basic principle that certain factors or even a single factor may prevent the growth of a plant or animal in a given place, permits a beginning for investigating the very complex problem of factors and their interactions as well as the effect of the factors on organism. Of course, this factor must be identified and this identification may be more or less complex in itself.

It is obviously impossible for each of you to have a battery of expensive recording instruments to measure each and every environmental factor, even though some of these may be available. However, a great amount of information can be obtained from much simpler instruments, some of your own design.

* "Field Ecology" A Laboratory Block by the Biological Sciences Curriculum Study and Edwin A. Phillips, D. C. Heath and Company, Boston, 1965.

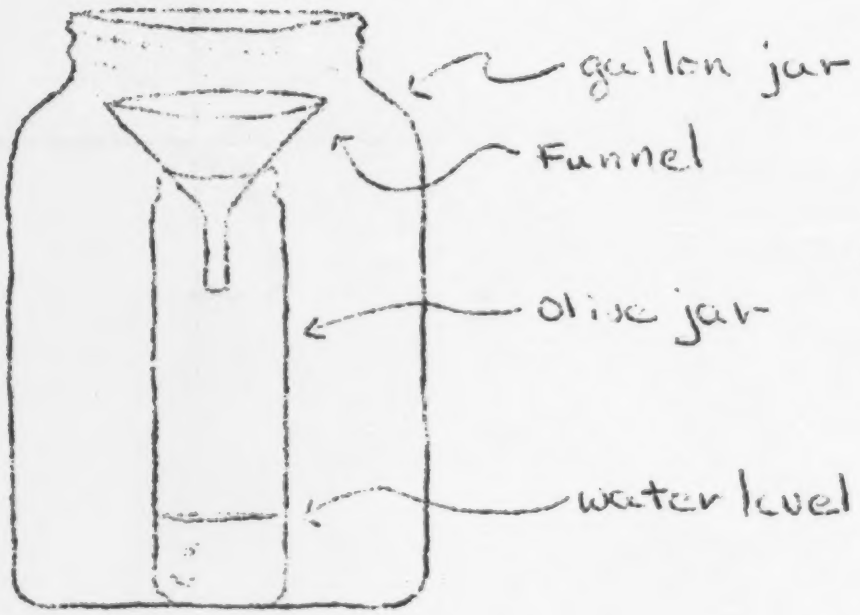
## Precipitation*

### Materials

2" diameter olive bottle
4" funnel
Gallon glass jar
Stake
String

### PROCEDURE

An effective rain gauge can be constructed with a 2" diameter olive bottle and a 4" funnel (top diameter), the whole set being placed inside a gallon glass jar. With equipment of these proportions, 4" of water collected in the bottle means 1" of rain per square inch of surface. One inch in the olive bottle therefore means 1/4" of rainfall. Any water overflowing into the larger jar must of course be poured into the smaller bottle and included in the measurements. Set the apparatus on the open grassy lawn and wire it to a short stake.




*"Teaching Elementary Science: A Sourcebook for Elementary Science, Harcourt, Brace & World, Inc., 1962.

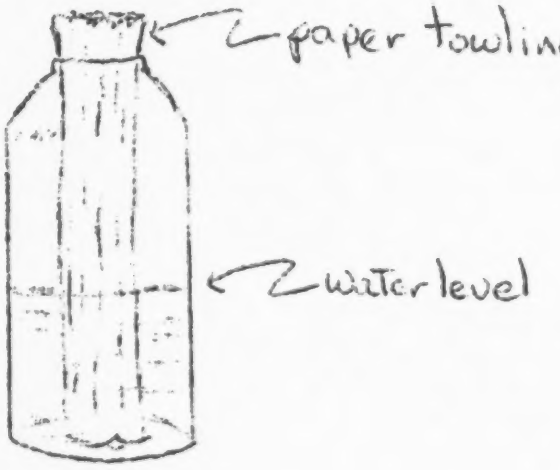
## Humidity

## Materials

Pint jar
Paper toweling

## PROCEDURE

Fill a narrow mouthed pint jar 1/4 full of water. Roll paper toweling into a solid cylinder, the diameter of which fits snuggly into the top of the jar. Leave several inches of the toweling exposed above the bottle mouth. The bottom of the towel cylinder should touch the bottom of the jar. Mark the point at which the water level stands after the toweling is inserted. Place the jars along the transect and note daily any change in the level of the water in the jars. The greater the rate of evaporation from the jar, the smaller the amount of moisture in the air. The students may set up their own scale for humidity.



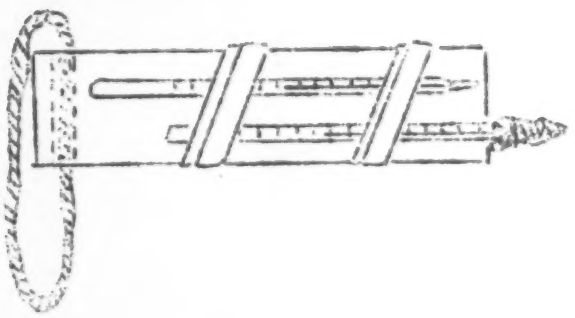
## Humidity — Sling Psychrometer

### Materials

Two thermometers
12 x 4 inch board
Gauze
Tape or wood screws

### PROCEDURE

Place two ordinary thermometers on a narrow board, and attach a wet gauze to one bulb. Attach the thermometers securely by means of wood screws or several layers of strong tape. Bore a hole to carry strong cord near the top of the thermometers. Pass a strong cord tied in a loop through the hole. Whirl the device overhead for 2 minutes. Note the difference between wet- and dry-bulb readings. Find the relative humidity or per cent of moisture in the air for each day the transect is studied. The higher the temperature, the greater the amount of moisture the air can hold.



* Hone, Joseph, Victor, Brandwein, A Source Book for Elementary Science, Harcourt, Brace and World, Inc., 1962, p. 105.

## Temperature

### Materials

Centigrade thermometer
Garden trowle
Yard stick

The class should decide what areas of the environment of their transect could be measured in regard to temperature. These areas may be measured in each transect interval. An example could be temperature readings taken two inches below the soil surface, at the soil surface, and in the air two feet above the soil surface. When making temperature readings below the surface the students may dig a small hole in the soil, insert the thermometer, and push the soil back around the bulb. When taking any temperature reading care should be given that the thermometer bulb is always shielded from direct sun, since the measurement desired is air or soil temperature, not heat absorption by the bulb in direct sun.

## Light Intensity*

### Materials

Ozalid paper (available from blue-print supply houses)
Ammonia Hydroxide conc.

### PROCEDURE

A stack of 15 sheets of ozalid paper all placed with the pale yellow coated side uppermost may be stapled down one side and cut into strips forming booklets. These operations should be carried out in dim light and the booklets stored until needed in a darkened container away from heat and damp. Petri dishes or sealed plastic bags may be used to protect the booklets from rain. Care should be taken so the sensitive surface is held flat against the inner surface of the container.

After exposure, containers may be taken to a dimly lit place, and the booklets removed and labeled. These may be stored in the dark or developed at once in ammonia vapor. A useful developing jar can be made by boring two small holes in the lid of a wide-mouthed gallon jar. A piece of wire is then pulled through the holes, and a wire basket fashioned and suspended from the underside of the lid. Sufficient room should be left for easy insertion of the booklets into the basket. About 25 ml. of concentrated ammonium hydroxide are then poured into the jar, and the screw cap replaced. The length of the wire should be adjusted so that the booklets are suspended about one inch above the surface of the ammonia. Development time should be about 10-20 minutes, to give time for the ammonia vapor to penetrate the booklets but there is no danger of overdevelopment. The number of paper layers affected by light can then be counted. Under a full day's sunlight the 11th or 12th page shows a faint bleaching. Use these booklets in each transect interval at points of possible variations in light intensity.

If comparing two or more transect intervals it is sufficient simply to indicate the relative number of bleached pages.

*"Field Ecology', A Laboratory Block by the Biological Sciences Curriculum Study and Edwin A. Phillips, D.C. Heath and Company, Boston, 1965.

## Wind

### Materials

Large bore tubing
Balsawood ball or pith ball

### PROCEDURE

Inexpensive, small anemometers are commercially available, usually working on the principle of the rotating vane. One might be constructed of a large bore tubing bent into an "L" shape. A pith ball or one made of balsawood could be inserted in the top of the vertical arm. The opening of the horizontal arm is held into the wind and the distance the ball rises due to the wind can be determined. *

WIND EQUIVALENTS — BEAUFORT SCALE
From U.S. Department of Commerce Weather Bureau

| Beaufort Number | M.P.H. | Knots | International Description | Specifications |
|---|---|---|---|---|
| 0 | Less than 1 | Less than 1 | Calm | Calm, smoke rises vertically |
| 1 | 1-3 | 1-3 | Light air | Direction of wind shown by smoke drift; but not by wind vane |
| 2 | 4-7 | 4-6 | Light breeze | Wind felt on face leaves rustle; ordinary vane moved by wind |
| 3 | 8-12 | 7-10 | Gentle breeze | Leaves and small twigs in constant motion; wind extends light flag |
| 4 | 13-18 | 11-16 | Moderate breeze | Raises dust, loos paper; small branches are moved |
| 5 | 19-24 | 17-21 | Fresh breeze | Small trees in leaf begin to swa crested wavelets form on inland waters |
| 6 | 25-31 | 22-27 | Strong breeze | Large branches in motion; whistling heard in telegrapl wires; umbrellas used with difficu ty |

| Beaufort Number | M. P. H. | Knots | International Description | Specifications |
|---|---|---|---|---|
| 7 | 32-38 | 28-33 | Moderate gale | Whole trees in motion; inconvenience felt in walking against wind |
| 8 | 39-46 | 34-40 | Fresh gale | Breaks twigs off trees; generally impedes progress |
| 9 | 47-54 | 41-47 | Strong gale | Slight structural damage occurs; (chimney pots, slates removed) |
| 10 | 55-63 | 48-55 | Whole gale | Seldom experienced inland; trees uprooted considerable structural damage occurs |
| 11 | 64-72 | 56-63 | Storm | Very rarely experienced; accompanied by widespread damage |
| 12 | 73-82 | 64-71 | Hurricane | |
| 13 | 83-92 | 72-80 | | |
| 14 | 93-103 | 81-89 | | |
| 15 | 104-114 | 90-99 | | |
| 16 | 115-125 | 100-108 | | |
| 17 | 126-136 | 109-118 | | |

* "Field Ecology" A Laboratory Block, Biological Sciences Curriculum Study and Edwin A. Phillips, D. C. Heath and Company, Boston, 1965

# SOIL STUDIES

As a youngster you undoubtedly played with soil and many a child gourmet is inclined to favor soil as a between-meal snack. Soil is many things to many people but it is not dirt! Dirt is defined in contemporary dictionaries as "any foul substance." Contrast this with the poet's description of soil as "the earth's sweet flowing breast."

Soil is related to the earth much as the rind is related to an orange, but the rind of the earth is far less uniform than that of an orange. Soils are deep in some places and shallow in others. They may be red, as in Hawaii, or black, as they are in North Dakota. They may be sand or they may be clay. Whether deep or shallow, red or black, sand or clay, soil is the link between the rock core of the earth and all surface life.

The soil mantle of the earth is not uniform but all soils have some things in common. Every soil consists of mineral and organic matter, water, and air. Moreover, it has length, breadth, and depth, and harbors an intriguing population of large and small organisms.

Every soil has a profile — a succession of layers in a vertical section down into bedrock. The nature of the soil profile has a lot to do with its ability to support life and to those who can read it, the soil profile is a historic record. It consists of two or more layers lying one below the other, parallel to the land surface. The layers are known as horizons. The horizons differ from each other in one or more properties, such as color, texture, structure, consistency, porosity, and reaction. Soil horizons may be from a fraction of an inch to several feet thick, but generally they lack sharp boundaries and tend to merge. They can be likened to the parts of a layer cake without the clear bands of icing between.

Most soil profiles consist of three main horizons identified by the letters A, B and C. The A horizon, the uppermost layer in the soil profile, is frequently called the surface soil. It is in this part of the soil that life is most abundant and is, therefore, the part in which organic matter is most plentiful. Because it lies at the surface, the A horizon is also that part of the soil which is constantly extracted by rainwater and, therefore, has a reduced content of soluble substances.

The B horizon lies immediately below the A horizon and is often called the subsoil. Living organisms are fewer here than in the A horizon but more abundant than in the C horizon. Color is often transitional to that of the A and C horizons, and the B horizon, when dry, is generally harder than its neighbors. The C horizon is the deepest of the three and consists of the parent material of the soil. It is low in organic matter and commonly lighter in color than the A and B horizons. Each of these master horizons can be subdivided and the kinds of arrangements of horizons in a profile are a record of the genesis of the soil. This record or history has meaning to soil scientists and is of great significance to an understanding of the formation, fertility, and productivity of a soil.

Soil is formed by the disintigration of rocks, under the influence of climate. Heating and cooling, freezing and thawing, wetting and drying, all tend to weaken rock structure. The minerals in rocks react with water and air that enter through tiny cracks and crevices. Chemical changes set up stresses and strains which further weaken the rock structure. As a result of these forces rocks disintegrate, often into their constituent mineral particles. This loose and weathered rock material gives rise to soil.*

* "Life in the Soil" A Laboratory Block by the Biological Sciences Curriculum Study and David Pramer. D.C. Heath and Company, Boston, 1965.

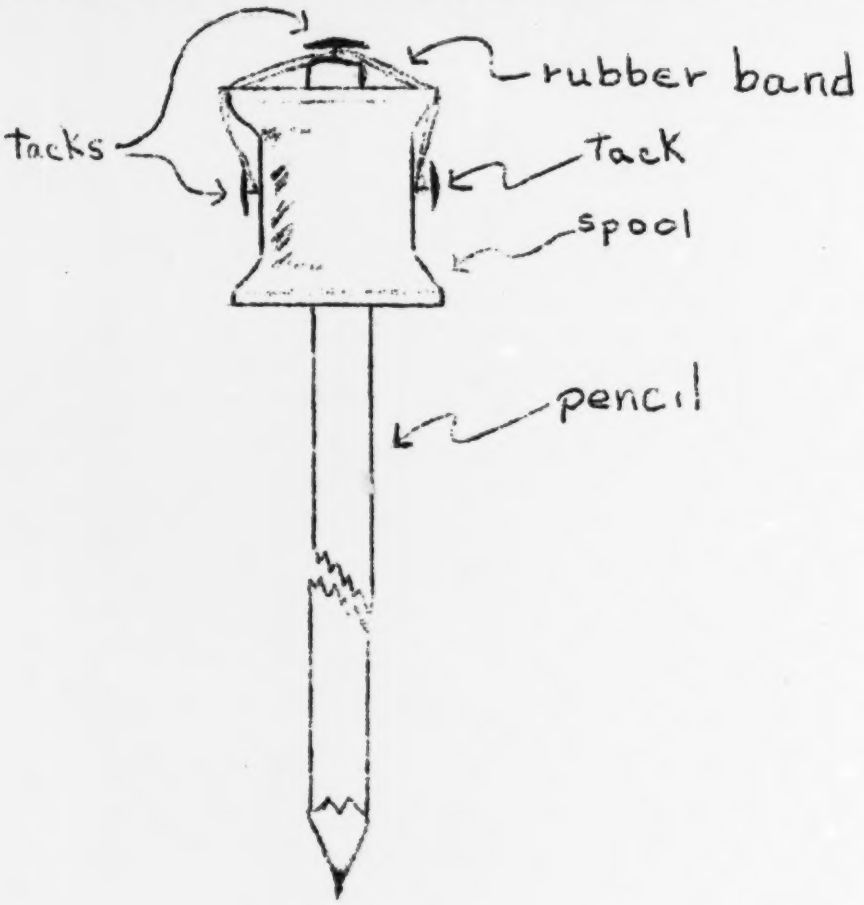
## Soil Compactness

### Materials

Pencil
Empty thread spools
Rubber bands
Tacks
Ruler

### PROCEDURE

This instrument may be used to show relative soil compactness along the transect. The pencil lead should be sharpened and then rubbed across paper to form a sharp but sturdy point. Use the instrument by grasping the thread spool, and shoving the pencil into the soil until the lead point is covered. Measure the distance the spool moved down the pencil. This distance will be determined by the amount of force required to push the lead into the soil, and therefore can be used as a measure of soil compactness.



SOIL TYPE —

Soil Type — Texture Method *

Materials

Soil
Plastic bags
Water

PROCEDURE

Collect samples of soil in the plastic bags from various points along the transect. Label each sample according to its position on the transect. Return to the classroom and moisten a small soil sample in the palm of your hand and rub the moist soil between the thumb and finger. Note whether it feels gritty or smooth and sticky. Let a small stream of water flow over the soil in your hand and wash away the finer particles. Note the amount of sandy material that remains in your hand.

The following guide should help you decide the kind of soil you have.

(1) Washed sample shows very little sand; wet sample feels very sticky and greasy when rubbed between thumb and finger. Read (2)
(1) Washed sample shows a medium to large amount of sand; wet sample feels moderately or only slightly sticky. Read (3)
(2) Dry, sifted soil feels smooth and velvety. Silt loam
(2) Dry, sifted sample feels harsh due to clay granules.
Clay Clay loam

(3) Washed sample shows only a medium amount of sand; dry sample may feel gritty, velvety or harsh; wet sample feels moderately sticky. Medium loam
(3) Washed sample shows very large amount of sand and fine gravel; dry sample feels very gritty; wet sample has little stickiness. Read (4)
(4) Sample shaken with water quickly, leaving only slight cloudiness in the water. Sand
(4) Sample shaken with water settles somewhat slowly and leaves considerable cloudiness in the water. Sandy loam

*Adapted from "Unit Study of Ecology." Prepared by Minnetonka School District #276, Excelsior, Minnesota, 1963.

## Soil Type — Profile Method

### Materials

Pint jars
Garden trowels
Plastic sandwich bags

### PROCEDURE

Remove one scoop of soil from each transect interval. Place each sample in an individual plastic bag marked with the symbol designating the transect from which it was taken. Fill pint jars 1/3 full of the soil samples. Add water to these jars until they are filled to one inch from the top. Seal the jar and shake the soil and water mixture thoroughly. Place the jars where they will not be disturbed for at least two days. The soil will settle in layers with the large particles settling first and the smallest size particles last. The samples may settle in the following way: First layer, coarse sand; second layer, fine sand; third layer, silt; fourth layer, clay. The relative heights of these layers may be compared between soil samples. The students may assign a name to the soil by referring to the particle layer (or layers) which is predominant.

## Moisture Content *

### Materials

Plastic bags
Oven
Juice cans, 5 per team
Filter paper, 5 sheets per team
Rubber bands, 5 per team
Soil
Balance

### PROCEDURE

Collect about five samples of soil in plastic bags along the transect at predetermined sampling points. Return to the classroom. Secure a piece of filter paper over one end of a cylinder (frozen fruit juice can with both ends removed) using a rubber band. Weigh the cylinder with the filter paper in place. Soil is then added to the cylinder (one-third full), and the unit is reweighed. The difference in weight is equal to the amount of soil added. Place the cylinder containing soil in an oven at 100 to 110°C for 24 hours. Reweigh the unit. The loss of weight due to drying is equal to the amount of water in the original soil sample. If 50 g of soil was used and the weight of soil after drying was 40 g, then the total weight of water in that sample was 50—40, or 10 g. The percent moisture content of the soil is calculated using the following formula:

Percent moisture =

$$\frac{\text{Loss of weight due to drying}}{\text{Weight of ovendried soil}} \times 100$$

(Save the dried samples for water-holding capacity technique.)

* "Field Ecology" A Laboratory Block by the Biological Sciences Curriculum Study and Edwin A. Phillips, D.C. Heath and Company, Boston, 1965.

## Water-Holding Capacity *

### Materials

Materials from Moisture Content Activity
Plastic or enamel pan, 1 per team

### PROCEDURE

The cylinder of soil previously dried in an oven at 100°C for 24 hours to determine moisture content is now employed to measure moisture-holding capacity. The filter paper covering one end of the cylinder is moistened with a few drops of water and the unit is weighed. The lower half of the cylinder is then immersed in water overnight in plastic or enamel pans. Lift the cylinder from the water, place it on a rack, and allow the soil to drain for approximately 30 minutes. Wipe the surface of the cylinder dry and weigh the unit. The moisture-holding capacity in percent is calculated using the following equation:

$$\text{Percent moisture-holding capacity} = \frac{\text{Gain in weight due to immersion in water}}{\text{Weight of ovendried soil immersed in water}} \times 100$$

The gain
The gain in weight is obtained by subtracting the combined weight of the cylinder and dry soil from that of the cylinder and wet soil.

*"Field Ecology" A Laboratory Block by the Biological Sciences Curriculum Study and Edwin A. Phillips, D.C. Heath and Company, Boston, 1965.

## Soil Acidity-Alkalinity

### Materials

Soil
Red and Blue Litmus Paper
pHydrion Paper
Distilled Water
Plastic Bags

### PROCEDURE

Collect soil at predetermined points along the transect in plastic bags. Make certain the bags are marked according to where they were collected.

Return to the classroom and dry the soil in the oven or as left standing overnight. Small samples, one gram or so, will be sufficient for the test. When the soil is dry, place several drops of distilled water on it to moisten it. Next, moisten the litmus or pHydrion paper by placing it in the damp soil. Note any color change. Read the scale on the roll of pHydrion paper for acidity-alkalinity index. If litmus paper is used, blue litmus will turn pink to red in acidic soil; pink litmus will turn blue in alkaline soil.

## Soil Capillarity*

### Materials

3 Transparent, water resistant cylinders (lamp chimneys; open-end juic cans may be used, if necessary)
3 Small pans or low, wide mouthed jars
Thin cloth
String or rubber bands

### PROCEDURE

Fasten the cloth over the top of the cylinders. Turn them upside down and fill each three-fourths full with one of the following dry soils:

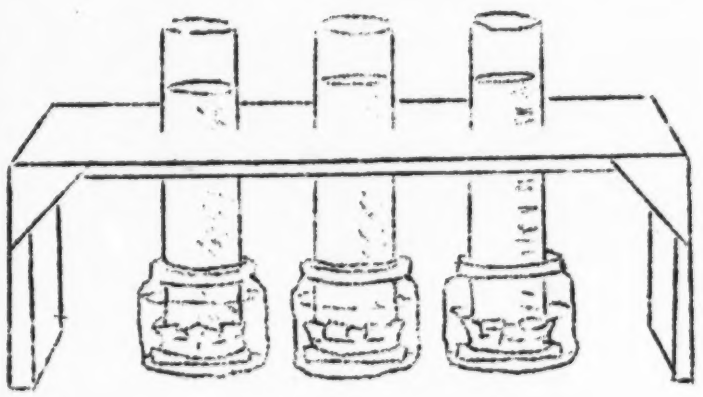
1. Sand.
2. Clay soil. This kind of soil is sticky when wet and dries in hard clods. Grind up the clods and put the dry clay in the chimney.
3. Dark, crumbly soil like that found under good grass sod. Or get topsoil from a garden or commercial nursery.

Jar the cylinders slightly by bumping on a table to settle the soil. Be sure the soils are dry.

Set the cylinders in the jars and pour water in the jars -- do not pour water in the cylinders.

Keep a record of how long it takes the water to move up 1 inch, 2 inches and 3 inches in each cylinder. Note how long it takes for the water to reach the top or whether it ever reaches the top.

The idea is to compare the capillary movement of water in coarse, medium and fine soil particles.



*U.S. Dept. of Agriculture, Soil Conservation Service, "A Guide For Leaders of Girl Scouts, Soil and Water Conservation Activities", 1965.

## Organic Matter — Ignition Method

### Materials

Balance
Soil Sample, 10 or more grams
Trowie
Tin Foil
Oven

### PROCEDURE

The organic matter content of soil may be determined by ignition.

Ignition is accomplished by placing a known weight of soil, previously dried at 100 to 110 deg. C. for 18 to 24 hours, in a furnace at 600 deg. C. or under a broiler for approximately two hours. During ignition, organic matter is oxidized to carbon dioxide and water, both of which are dissipated rapidly by the high temperature. It is recommended that 10 g. of dried soil be ignited in a tinfoil dish. After ignition, the sample is cooled and weighed. The loss of weight due to ignition is equal to the organic content, and from this figure the percent organic matter of the soil can be calculated easily.

$$\text{Percent organic matter} = \frac{\text{Loss of weight due to ignition}}{\text{Weight of dry soil before ignition}} \times 100$$

Examine the residue in the dish after ignition. Of what do you think it consists? *

* "Life in the Soil" A Laboratory Block by the Biological Sciences Curriculum Study and David Pramer. D. C. Heath and Company, Boston, 1965. (adapted from)

## Organic Matter — Chemical Method*

### Materials

Test Tube
2% solution Sodium Hydroxide
Soil, several grams

### PROCEDURE

1. Place some of your soil to a depth of about two centimeters in a clean test tube.
2. Carefully add about three times the volume of 2% sodium hydroxide solution.
3. Shake the solution well for two or three minutes.
4. Let the mixture settle and stand for 24-48 hours. Be sure that the test tubes are labeled.
5. Observe the color of the solution above the material that has collected at the bottom of the test tube. Use the following color key when observing the color of the solution:

   Color Key for Available Organic Matter - - -

   Jet black liquid — high available organic matter content content

   Dark brown-black — medium available organic matter content

   Any lighter shade — low available organic matter content

* Adapted from "Unit Study of Ecology" Prepared by Minnetonka School District #276, Excelsior, Minnesota, 1963.

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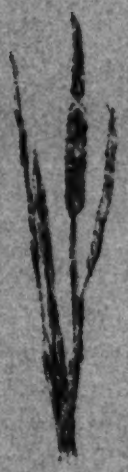
# TRANSECT ACTIVITIES II



Environmental Science Center
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Golden Valley, Minnesota
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## Plant Life — Survey Along a Transect

### Materials

Scissors
Baggies

### PROCEDURE

A study of an individual plant type (species) along a transect is concerned with (1) the frequency of its occurrence, (2) its abundance, (3) cover or space occupied (volume of above ground parts), and (4) density. When the results of these four studies are considered and correlated with abiotic factors along the transect a picture of the plant in relation to its environment becomes evident.

Begin at one end of the transect and proceed to examine each predetermined transect interval independently. Samples of each plant type occurring within the transect should be collected. Collect the root system if possible; they may be dug out with garden trowels. If it is not possible to include roots, pinch or cut away sample plants as close to the ground surface as possible, thus collecting all of the above surface plant parts. Trees and bushes may be sampled by taking only a leaf or part of a branch.

The plant samples may be taped to a sheet of paper. Each plant type can be "named" by giving it a number or letter designation. No more than one sample of each plant type (species) need be taken over the entire transect. Uniform symbols for each plant type should be established among students so data can be handled collectively when the study has been completed. Determinations on frequency, abundance, and cover are made as follows:

The frequency of a single species or plant type is expressed as the total number of transect intervals in which that plant occurs. For instance, marsh marigolds may have a frequency of one in a transect extending away from a pond edge because they may appear within only the first interval. However, they might show a frequency of ten in a transect paralleling the pond edge.

Abundance may be considered with regard to relative numbers of plant types within a transect interval. Abundance is independent of either frequency or cover. An arbitrary abundance scale such as the following may be set up. The scale is applied to each transect interval.

| Number of Plants | Abundance Rating |
|---|---|
| 10 or less | A. |
| 10 to 50 | B. |
| 50 or greater | C. |

Bushes and trees are included in abundance determinations if their trunks are within the t

Plant Life Continued

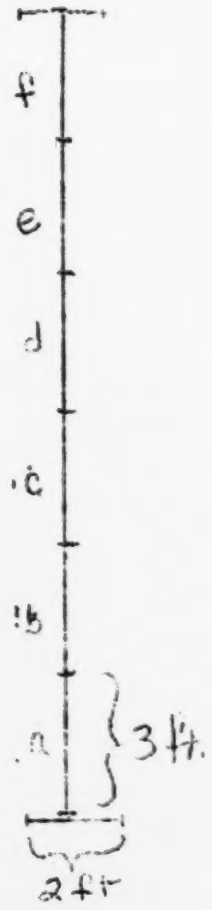
The influence of plants on one another (crowding, over-crowding) can be determined by measurement of plant density. The class may examine the plant types in each transect interval to find if they are continuous (plants are side by side); if they are intermittent (plants do not touch), or if they are scattered singly or in disconnected patches such as woody plants might be. The following symbols might be used to designate density of plant types.

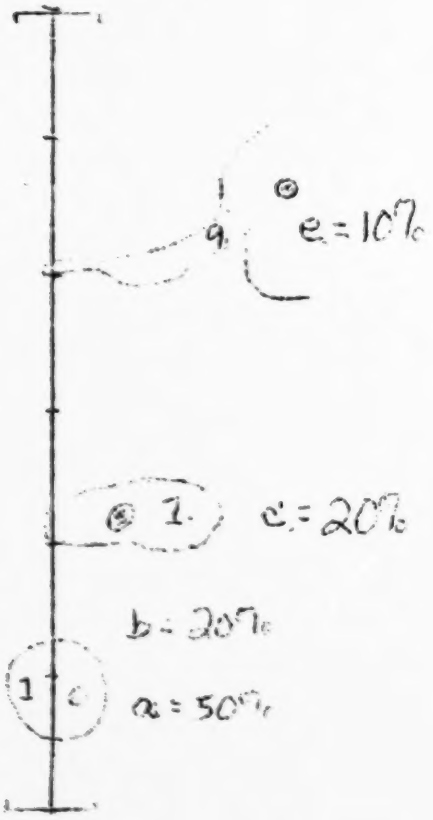
c = continuous
i = plants do not touch
p = woody plants, scattered singly or in groves, herbs in disconnected patches

Below is a hypothetical data sheet resulting from a plant transect survey.

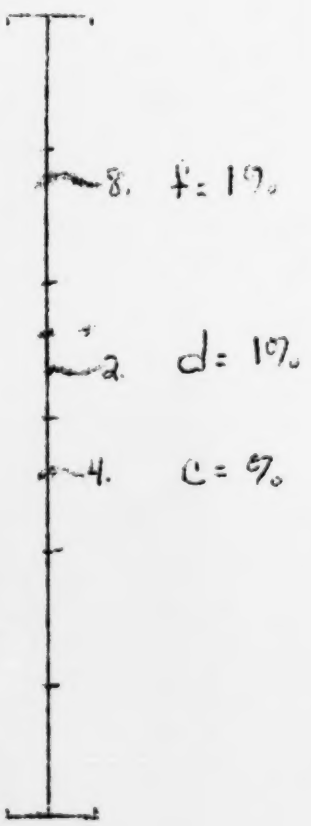
| Plant Survey Data | | | | | | |
|---|---|---|---|---|---|---|
| Structural type | Plant type | Intervals in which found | Abundance | Frequency | Cover | Density |
| trees & bushes | 1. | a | A | | 50% | p |
| | | b | A | | 20% | p |
| | | c | A | 3 | 20% | p |
| | 9. | e | A | 1 | 10% | p |
| Mosses & Lichens | 2. | d | B | 1 | 1% | p |
| | 4. | c | B | 1 | 1% | p |
| | 8. | f | A | 1 | 1% | i |
| Grasses & Herbs | 3. | a | C | | 90% | c |
| | | b | C | | 50% | c |
| | | c | B | 3 | 40% | i |
| | 5. | c | B | 1 | 50% | i |
| | 6. | d | C | | 90% | c |
| | | e | B | 2 | 100% | c |
| | 7. | f | B | | 80% | p |
| | | d | C | 2 | 10% | p |

**Possible Transect Sketch for Cover (see data sheet)**




trees and bushes




Mosses and lichens

Grasses and herbs

within the established transect width or if their branches over-hang the transect width.

Cover is determined according to the general type of plant structure observed i.e., trees, bushes, herbs and grasses, and mosses and lichens.* Examine the transect four separate times focusing upon one of the structural types during each study. Prepare a separate transect sketch for each structural type.

Trees —

Examine the transect width and length and note any included or over-hanging trees. Place yourself under the tree and over the transect line at these points. Imagine the sun as being directly over-head and sketch the shadow it would cast in the appropriate transect interval. Each shadow sketch is labeled with the symbol assigned that plant type.

Bushes —

Re-examine the transect for shrubs and again sketch them in the transect interval as though drawing their shadow.

Herbs and Grasses; Mosses and Lichens —

Cover for these plants should be estimated for each transect interval. Include only those which seem to cover an area to the exclusion of all but a few intermittent individuals. Concern should be taken to establish correct proportions between the plant life types as represented on the sketch. If these proportions are accurately recorded, cover can be expressed in appropriate percentages.

*Lichens — an algae and a fungi growing in close association. There is very loose attachment to a substrate, they are commonly found on rocks and tree trunks.

## Invertebrate Collection — Sorting

### Materials

Killing jar (appendix)
70% alcohol
Baby food jars

### PROCEDURE

Many invertebrates can be found living within leaf litter, dead and rotting logs, under stones, within bark crevices, etc. This kind of collecting requires a good eye and a quick hand. The organisms are captured by hand and placed in the killing jar. After movement has ceased they may be put into 70% alcohol for preservation. The preserving bottle is labeled designating the interval from which the organisms were taken. Some of the more decomposed leaf litter and rotting logs may be studied using the Burlese funnel in a fashion similar to the way in which it was used with the soil samples.

## Invertebrate Collection — Fly Paper

### Materials

Fly paper or strips (appendix)

### PROCEDURE

Cut the fly paper into small squares 1 1/2 inch by 1 1/2 inch. These may be fastened to plants and other objects along the transect. The students might attach the papers to rocks, leaves, flowers, bark, etc. Some interesting assumptions about the habits of the invertebrate may result. For example, if a certain type insect were collected several times from the same type of plant, the children might assume that the plant is of some importance in the life of that type insect.

## Invertebrate Collection — Fall Trap

### Materials

Garden Trowel
Soup Cans
70% Alcohol

### PROCEDURE

The fall trap may be made from a soup can, buried so the top edge is flush with the ground surface. About one inch of 70% alcohol is poured into the can. Organisms fall into the trap as they pass over the ground surface. One can for each transect interval should provide a complete collection. Collection from the cans may be made daily. Organisms from each interval should be maintained in separate containers and these containers labeled with the symbol designating the interval. Comparisons may be made between transect intervals and between transects in regard to types of organisms and numbers of these types.

## Invertebrate — Plaque Method

Materials
Plastic tiles or flat stones
Killing jar (see appendix) or container of 70% alcohol

### PROCEDURE

Many invertebrates which live at the soil surface seek damp, cool places. They are attracted to flat objects which provide such a situation. This behavior can be taken advantage of by placing weighted tiles or other flat objects such as rocks along the transect. Do not disturb the objects for three days to a week. After that period of time you may begin making daily collections.

## Invertebrate Collection — Netting Method

### Materials

Insect net (see appendix)
Killing bottle (see appendix)
70% alcohol (preservative)
Insect pins
Fly paper

### PROCEDURE

A standardized procedure for collecting with an insect net must be established and observed by the class. The children might "sweep" the area along a transect interval by holding the net opening parallel to their bodies and swinging it quickly from one side to the other a particular number of times per transect interval. After each sweep the net contents should be emptied into the killing jar. When a transect interval has been completely swept, and after all movement in the killing jar has ceased, the organisms collected from that interval are placed in a container of 70% alcohol. The container may be labeled with the symbol designating the interval from which the collection came. Comparisons may be made with regard to types of insects collected and numbers of the types.

## Invertebrate Collection — Berlese Funnel

### Materials

Berlese Funnel (see appendix)
Garden Trowels
70% alcohol
Plastic sandwich bags
Balance

### PROCEDURE

Remove a scoop of soil with the garden trowel from each transect interval and place it in a plastic bag. Each sample should be labeled with the symbol of the transect interval from which it was taken.

Retrun to the classroom and place the samples into Berlese funnels. Take care so that the transect interval source designation is not lost in this transfer. The application of heat and the resulting dryness drive the soil organsism deeper into the soil sample. They eventually move out the end of the funnel and into a vial of alcohol preservative.

The study of the soil organisms can be made more quantitative if the amount of soil placed in the Berlese funnel is of a specific weight. For example the class might study only 8 ounces of soil from each interval. This makes it possible to compare both types and numbers of types between transect intervals and between transects. It must be remembered, however, that water content of the soil has not been considered when weighing out the samples.

## Soil Micro-organisms — Buried Slide Technique *

### Materials

Microscope
Microscope slides
Cake pan and rack
Corn flakes
Tumblers
Phenolic rose bengal stain

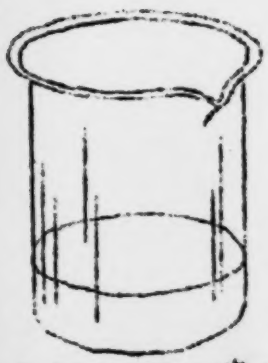
### PROCEDURE

The procedure commonly used for determining the abundance of the elements of the soil population have the common fault that the soil material is greatly disturbed during treatment. In fact, the object of dilutions is to disperse the soil material as completely as possible. Consequently, from such methods one can obtain no idea of the actual relations between organisms in soil or their association with the inanimate soil particles. Armed with the results of such previous studies you would be hard pressed to provide answers to the following questions. Do bacteria, actinomycetes, and fungi form colonies in soil as they do on agar media, or do they develop as small clusters or single cells dispersed throughout the soil system? Do filamentous fungi fruit and produce spores in soil? Do different soil organisms develop in proximity to one another, and what is their relationship to soil particles?

The buried-slide technique was the first by which some idea of the actual characteristics of the soil population in relation to its environment could be noted. It is not a means by which the numbers of cells in a definite unit of soil can be accurately measured, but a procedure by which certain qualitative characteristics of the population can be observed. The method is extremely simple. It consists of inserting a clean microscope slide into soil. After an appropriate interval of time, the slide is withdrawn and allowed to air dry. One side of the preparation is cleaned and the other is then fixed, stained, and examined microscopically. The picture obtained is a composite of the development in soil over a period of time to those organisms that were in contact with the slide. Slides can be buried in soil supplemented with organic matter and incubated under different environmental conditions. In this way the influence of various factors on the interrelationships of soil organisms can be observed. The buried-slide technique is a simple but excellent tool that provides a candid view of soil organisms in their natural habitat.

Weigh two 200-g portions of each soil to be tested. Leave one portion of each soil untreated. To the other add 1.0 g of powdered cornflakes or any other cereal. Grind the cornflakes in a mortar and pestle or thoroughly crush them with a rolling pin. Spread the soil on a piece of paper, sprinkle the powdered cornflakes over the surface, and with a spatula, thoroughly mix the organic material into the soil. Add the soils to tumblers containing sufficient water to bring them

to 60 percent of moisture-holding capacity. Make a slit in the soil and insert into each tumbler a cleaned microscope slide. The water layer at the bottom of the tumbler will rise slowly by capillarity, bringing the soil to optimum moisture and insuring contact between the slide surface and soil particles. Cover the tumblers and store them at 28°C for 7 days.



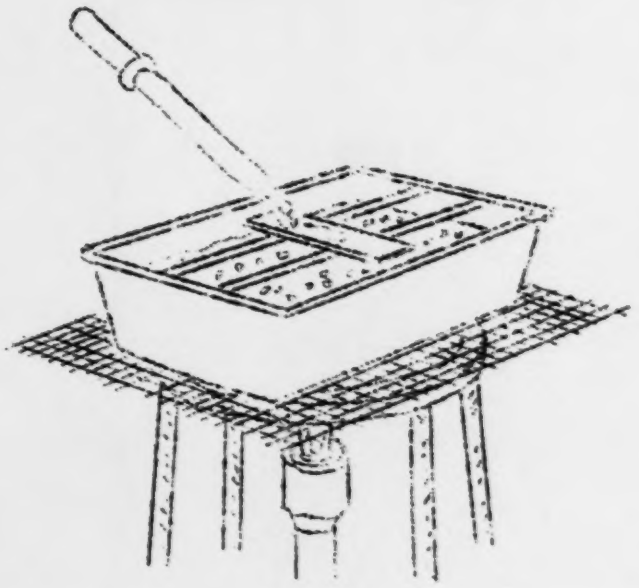
Sufficient water to bring soil to 60% M.H.C.

Add soil

Insert Slide

Cover and Store 7 Days

Remove Slide Leaving one Side Undisturbed



Stain over boiling water bath for 8 minutes, wash and examine microscopically

Remove the slide from each tumbler in a manner such that one face is not disturbed. One surface will break cleanly from the soil if the slide is compressed to an inclined position before removal. It is this undisturbed surface which will be stained and examined microscopically. Clean the other side with a damp cloth and permit the slide to air dry. Gently tap to dislodge large soil

particles and then heat fix the preparation by three or four rapid passes through the flame of a boiling water bath and flood the surface with phenolic rose bengal. Stain for at least 5 but not more than 10 minutes and do not permit the stain to dry o on the slide. Continue to add stain so that the slide surface remains flooded during the procedure. Then remove excess stain by passing the preparation through several changes of water. Permit the slide to air dry and examine it under the microscope. For detailed study examine your preparation under oil immersion.

Note the relationship of organisms to each other and to the soil particles. Did you observe fungus filaments, fruiting bodies, or spores? What was the size and shape of bacterial cells? Did the addition of organic matter to soil influence the results? How have the results affected your concept of the nature of the development of organisms in soil? Make sketches of typical fields.

## VERTEBRATE STUDIES*

Mammals and other vertebrates can be directly observed and collected, or indirectly assumed because of their traces, tracks, remains, sounds or homes. It is more difficult to determine frequency, abundance and cover for animals because they move about.

Abundance refers to the number of individuals present. For moving animals, sample plots can be used to determine abundance indirectly by counting the traces, tracks or homes of the various animals in the sample plot (or along a transect). Live trapping and marking animal individuals so that the same one will not be counted twice is another method of obtaining abundance data. Observation of unmarked animals is of some value for rough estimates only.

Frequency refers to the distribution of the individuals of a species. In a study area you might find ten rabbits and thus assign an abundance of ten to the rabbits. These ten rabbits could be confined to a relatively small part of the total area and thus have a low frequency. However, if these ten rabbits or their tracks or traces were found throughout the whole area, rabbits then would have a high frequency.

Generally a species is considered to have more influence and to be of more importance when it has a higher abundance and a higher frequency than another species.

Cover can be represented by the size of the animal although the concept of plant cover is one that includes its space demands. Therefore, the cover concept for animals would include not only animal size but also, to some extent, its range. Average sizes can be estimated for each of the animals observed. To supplement observations of the mammals, some of the following methods may be used.

* "Field Ecology", A Laboratory Block by the Biological Sciences Curriculum Study and Edwin A. Phillips, D.C. Heath and Company, Boston, 1965.

## Live Traps and Drift Fences*

Materials
Mason jar with lid
Stiff wire
Tin

### PROCEDURE

Modified Horne type: This live trap is constructed from the metal rim of a mason jar lid and can be used on any size jar upon which it will fit. The construction is shown in the diagram. Two holes are drilled in the lid, into which is inserted a stiff wire, bent at each end to hold the lid in place. The door, constructed of any metal and cut to shape, is bent over the wire as shown, but left loose enough to swing easily up and down. Food in the jar attracts the animal which pushes its way in. Then the weight of the metal door causes the door to drop back into place. Gophers have been caught in two-quart jars with a cup of rolled oats which served as food and also absorbed some moisture to keep the trap drier. Traps are placed with jar horizontal and usually completely covered with soil after being set in active runways. See the article by Richard Hansen, 1962, in Ecology 43: 151-154.

Materials
1/4 inch mesh hardware cloth
shovel

### PROCEDURE

Drift fence: Another trapping development that works well in open country and to some extent in forests is the drift fence. A temporary fence of 1/4 inch mesh hardware cloth is set up. Typically it is made approximately 30 cm high and 10 to 12 m long. A shallow ditch approximately 2 cm deep is made by dragging a shovel through the soil. The fence is then

*"Field Ecology", A Laboratory Block by the Biological Sciences Curriculum Study and Edwin A. Phillips, D.C. Heath and Company, Boston. 1965.

buried 2 cm deep. The fence material is stiff enough to need very little support, but wooden stakes or coat hangers bent in a "U" form may be used from place to place. Live traps or sunken pits are placed at intervals along the fence. The fence is cut so as to fit into the funnel of a funnel trap. The trap is placed in the center of the fence so that animals drifting along either side of the fence are directed into the trap. Pits are usually placed on both sides of the fence and may consist of cans from one to five gallons depending on the size of the animals expected. Short fences can be arranged in the form of a cross with live traps or pits in the corners. Then the direction of animal movement can be determined by the particular traps in which the animals land.

If the night is expected to be cold, a little cotton in the live traps will enable the animal to keep warm. Loose, dry oatmeal or oatmeal mixed with peanut butter is put in the can for bait. If there are many small animals in your area, it might be fun to try different baits and see which bait attracts the most animals. Artificial scents could also be used and perhaps different vegetable dyes to give different colors to the bait. Many investigators use plain peanut butter. The crunchy type is better if ants are expected because they have more trouble carrying away this type. If three to four teaspoons of bacon grease are added per pound of peanut butter, more shrews seem to be caught. Other investigators have used raisins, apples, berries, bananas and nuts as bait. Another investigator has used, with great success, dry soup mix (split peas, bean and noodle fragments, etc.) plus a small piece of fresh apple. The traps should be set out of direct sunlight where possible and set firmly with a slight tilt so water will drain out of the can. In the woods the traps should be placed near a tree trunk or log and in the field at right angles to animal runways, if they can be found. For an estimate of the population, a straight line with twenty stations has been suggested at 15 m intervals. At each station three traps are set within a radius of 2 m, perhaps with different baits.

## Pitfalls*

**Materials**
Two pound coffee cans

**PROCEDURE**

Sink cans in the ground so that the rim is even with the ground. When set along small animal trails, these collect shrews, for example, which are attracted by a little meat (or see suggestions on bait for live traps). Two pound coffee cans are a good size for many mammals.

## Scat Boards *

**Materials**
4 inch plywood squares or wall tiles

**PROCEDURE**

The droppings (scats) of animals will often appear on squares of tile distributed throughout a community. Four-inch plywood squares have been used but are heavier and more expensive than equally usable tan-colored plastic wall tiles 4-1/4 inches square. The use of different kinds and colors would provide a good experiment. If these droppings are identifiable, they provide good supplemental information as to range and occurrence. Scats seen elsewhere should also be identified where possible.

## Tracks*

**Materials**
White sand (optional)

**PROCEDURE**

White sand or a substitute can be sprinkled along an animal trail so that tracks show up better. Also wetting the dirt in certain areas where animals are expected will make tracks more visible. Studies of tracks in the snow are also good.

Richard Barthelemy, former Project Associate of the Committee on Innovation in Laboratory Instruction, Austin, Texas, has good success getting tracks in mud. A good slippery, gooey clay mud is spread evenly and trowelled smoothly on pieces of polyethylene just before nightfall so that evaporation is low. The area can be baited with a piece of food in the middle. Night animals such as raccoons, skunks and house cats are especially susceptible to this system. To preserve the tracks for more detailed study and identification, the tracks can be poured with plaster the next day.

*"Field Ecology", A Laboratory Block by the Biological Sciences Curriculum Study and Edwin A. Phillips, D.C. Heath and Company, Boston, 1965.

## Homes: Dens, Burrows and Holes

**Materials**
none

**PROCEDURE**

General observation.

## Behavior

**Materials**
none

**PROCEDURE**

General observation.

## Birds*

### Materials

Binoculars (optional)

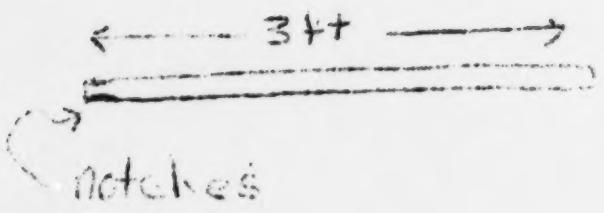
### PROCEDURE

For most practical purposes the birds must be studied by observations of sight and sound. Some students might set up bird blinds for observations of nests on weekends and after school. Binoculars are necessary for best observations and identifications, preferably 6 X 30 or 7 X 50. Bird tracks, eggs and nests also offer a means of presence and range indication. Records of bird songs are a good aid to this method of identification. Flight patterns, food habits, location and particular behavior patterns also are helpful and should be included in observations. The number of birds of different kinds heard and seen only while the students are working their transects helps to standardize concepts of abundance and range.

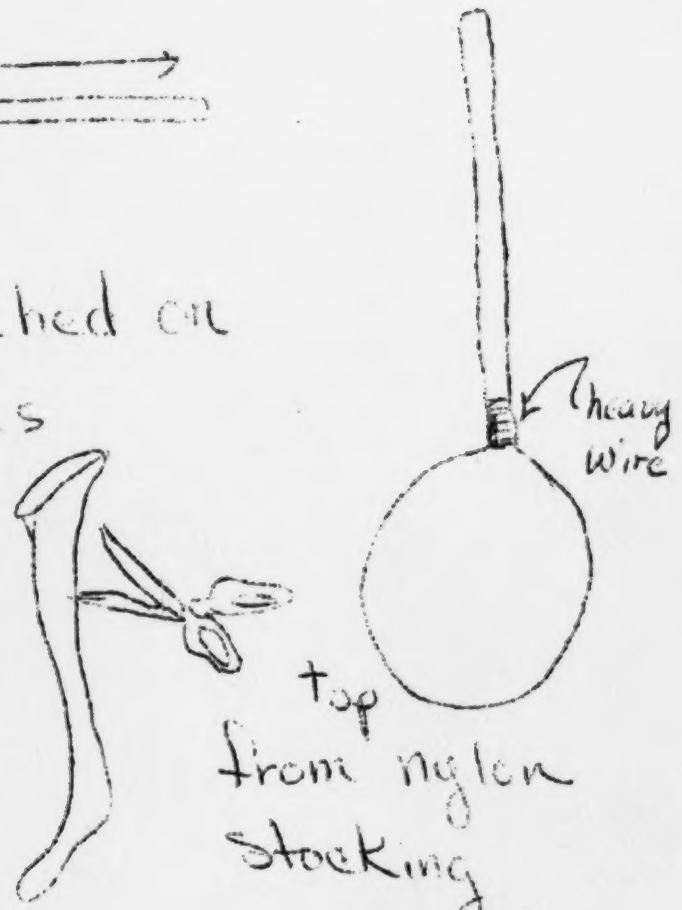
*"Field Ecology", A Laboratory Block by the Biological Sciences Curriculum Study and Edwin A. Phillips, D.C. Heath and Company, Boston, 1965.

**Insect Net**

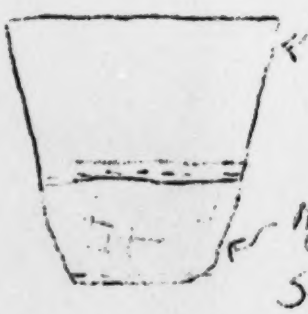
bent coat hanger




dowl notched on two sides



muslin or old sheet (two pieces sewn together)



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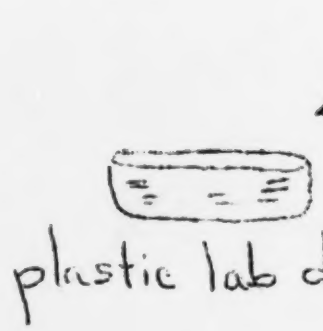
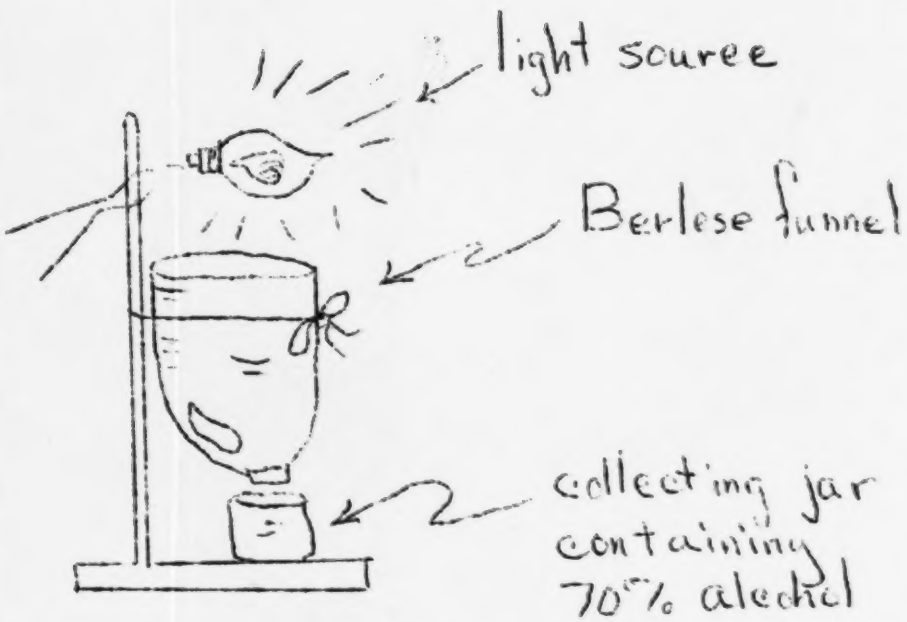
**Berlese Funnel**



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## Killing Jar

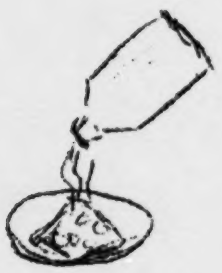
peanut butter jar

sponge

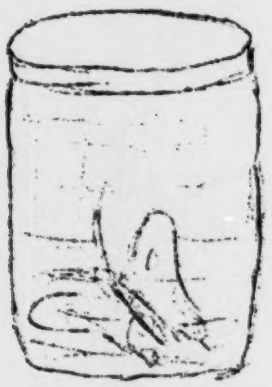
glue

nail polish remover

glue the sponge to the inside surface of jar cover



saturate the sponge with polish remover



wrap the jar with scotch tape to prevent shattering the glass if dropped

POOR ORIGINAL COPY - BEST AVAILABLE AT TIME FILMED

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